MINING AND RECLAMATION PLAN
SUFCO MINE
AMENDMENT

OPERATED BY

CANYON FUEL COMPANY, LLC
SUFCO Mine

WEST COAL LEASE MODIFICATIONS
SL-062583
U-47080
U-63214

AUGUST 2010

Canyon Fuel
Company, LLC
ern Bituminous Group, LLC

COPY

Incoming
C0410002
#3609
K

Sufco Mine
597 South SR24
Salina, Utah 84654
(435) 286-4880
Fax (435) 286-4499

August 25, 2010

Permit Supervisor
Utah Coal Regulatory Program
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
P. O. Box 145801
Salt Lake City, Utah 84114-5801

RE: West Lease Modification Amendment to the Canyon Fuel Company, LLC Sufco Mining and Reclamation Plan, Permit Number C/041/002

Dear Permit Supervisor:

Please find enclosed with this letter the Sufco Mine permit amendment to include the West Lease Modifications to three existing leases in the mine's M&RP. We have included four copies of the modified text and plates in redline/strikethrough format along with completed C1 and C2 forms. One additional copy was sent to the Price Field Office. Clean copies of the pages with modifications will be forwarded to the Division once the modification is approved for inclusion in the permit.

The permit modification is being submitted as a minor modification since the additional lease area requested represents about 9% of the total existing lease acreage. Also the additional lease area is within the existing CHIA, is within the hydrologic basin in which the mine has a permit to operate, and does not involve a change to the reclamation bond or liability insurance or operation after the cancellation thereof.

Much of the baseline information used for and included with this permit modification has been obtained from the United States Department of the Interior Bureau of Land Management, West Coal Lease Modifications Environmental Assessment UT-070-08-083. The criteria for which new water monitoring sites were chosen to be included in the existing Sufco ground and surface water monitoring program was based on the data obtained. This criteria included baseline flows, proximity to mining and subsidence, extent of development of springs, and whether or not the spring or surface water location had a State Water Right granted.

Sufco is anticipating entering the lease modifications in November 2011 to begin development mining for longwall panels. If you have any questions regarding the information contained in this letter or within the permit modification, please give Mike Davis a call at (435) 286-4421.

Sincerely,
CANYON FUEL COMPANY, LLC
SUFCO Mine

Kenneth E. May

Kenneth E. May
General Manager

Encl.

cc: DOGM - Price Field Office
DOGM Correspondence File

Sufpub\Govt2010\dogmmrp\West Lease Mod ltr 8-2010.doc

File in:
☐ Confidential
☒ Shelf
☐ Expandable
In C/041/0002 Incoming
Date: 08302010 For additional information

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APPLICATION FOR COAL PERMIT PROCESSING

Permit Change ☒ New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐ COPY

Permittee: CANYON FUEL COMPANY, LLC
Mine: SUFCO MINE **Permit Number:** C/041/002
Title: West Coal Lease Modifications Amendment to MRP.
Description, Include reason for application and timing required to implement:
Sufco has modified three existing coal lease areas. Sufco is anticipating entering the lease in November 2011.

Instructions: If you answer yes to any of the first eight (gray) questions, this application may require Public Notice publication.

☒ Yes ☐ No 1. Change in the size of the Permit Area? Acres: 24571.947 Disturbed Area: 0.0 ☐ increase ☒ decrease.
☐ Yes ☒ No 2. Is the application submitted as a result of a Division Order? DO# _____
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes ☒ No 6. Does the application require or include public notice publication?
☒ Yes ☐ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☐ Yes ☒ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # _____
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: ______
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☒ Yes ☐ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☒ Yes ☐ No 13. Does the application require or include collection and reporting of any baseline information?
☐ Yes ☒ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☐ Yes ☒ No 15. Does the application require or include soil removal, storage or placement?
☐ Yes ☒ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☐ Yes ☒ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☒ Yes ☐ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☒ Yes ☐ No 19. Does the application require or include certified designs, maps or calculation?
☒ Yes ☐ No 20. Does the application require or include subsidence control or monitoring?
☐ Yes ☒ No 21. Have reclamation costs for bonding been provided?
☐ Yes ☒ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☒ Yes ☐ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

Please attach four (4) review copies of the application. If the mine is on or adjacent to Forest Service land please submit five (5) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

KENNETH E. MAY, MINE MANAGER
Print Name

Kenneth E May 8/25/10
Sign Name, Position, Date

Subscribed and sworn to before me this 25 day of August, 2010
Krystal Rickenbach
Notary Public
My commission Expires: ____________, 20___}
Attest: State of ____________} } ss:
County of ____________

NOTARY PUBLIC
KRYSTAL RICKENBACH
580808
My Commission Expires
November 10, 2013
STATE OF UTAH

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining
		RECEIVED AUG 30 2010 DIV. OF OIL, GAS & MINING

APPLICATION FOR COAL PERMIT PROCESSING

Detailed Schedule Of Changes to the Mining And Reclamation Plan

COPY

Permittee: CANYON FUEL COMPANY, LLC

Mine: SUFCO MINE **Permit Number:** C/041/002

Title: West Coal Lease Modifications Amendment to MRP.

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Replace pages 1-5, 1-8 to 1-12 in Chapter 1 in Volume 1 of MRP.
☐ Add	☒ Replace	☐ Remove	Replace pages 3-iv, 3-6 to 3-14 and 3-44 in Chapter 3, Volume 1 of MRP.
☒ Add	☐ Replace	☐ Remove	Add new page 3-14A in Chapter 3, Volume 1 of MRP.
☐ Add	☒ Replace	☐ Remove	Replace pages 4-1, 4-5, 4-12, 4-12A and 4-13 in Chapter 4 in Volume 1 of MRP.
☐ Add	☒ Replace	☐ Remove	Replace pages 5-vi to 5-vii, 5-13, 5-17, 5-18, 5-18A, 5-23, 5-26, 5-27, 5-29 5-30, 5-39, 5-39F, 5-40, 5-51, 5-60 and 5-75 in Chapter 5, Volume 1 of MRP.
☐ Add	☒ Replace	☐ Remove	Replace pages 6-4, 6-8, 6-15 and 6-16 in Chapter 6 in Volume 2 of MRP.
☐ Add	☒ Replace	☐ Remove	Replace pages 7-vii, 7-2, 7-3, 7-5, 7-7, 7-12, 7-13, 7-17, 7-19B, 7-27, 7-30, 7-33, 7-36, 7-38D, 7-38E, 7-39, 7-41, 7-42, 7-47, 7-50 and 7-54 in Chapter 7, Volume 2 of MRP.
☐ Add	☒ Replace	☐ Remove	Plates 3-1 and 3-2 in Chapter 3, Volume 1 of MRP.
☐ Add	☒ Replace	☐ Remove	Plate 4-1A in Chapter 4, Volume 1 of MRP.
☐ Add	☒ Replace	☐ Remove	Plates 5-1, 5-5, 5-6, 5-10A, and 5-11 in Chapter 5, Volume 1 of MRP.
☐ Add	☒ Replace	☐ Remove	Plate 6-1 in Chapter 6, Volume 2 of MRP.
☐ Add	☒ Replace	☐ Remove	Plates 7-2A and 7-3 in Chapter 7, Volume 2 of MRP.
☒ Add	☐ Replace	☐ Remove	New West Coal Lease Modification documents at the back of Appendix 1-2 in Volume 4 of MRP.
☒ Add	☐ Replace	☐ Remove	West Coal Lease Modifications Environmental Assessment in Appendix 3-13 in Volume 5 of MRP.
☒ Add	☐ Replace	☐ Remove	New West Coal Lease Modification Water Right Data Sheets at the back of Appendix 7-1 in Volume 7 of MRP.
☒ Add	☐ Replace	☐ Remove	Add new PHC Appendix 7-24 in Volume 8 of MRP.
☐ Add	☐ Replace	☐ Remove	
☒ Add	☐ Replace	☐ Remove	Plate 3-3 in Confidential Folder of MRP.
☒ Add	☐ Replace	☐ Remove	Plates 5-10AC in Confidential Folder of MRP.
☒ Add	☐ Replace	☐ Remove	New Cultural Resource Inventory at the back of Appendix 4-2 in Confidential Folder of MRP.
☒ Add	☐ Replace	☐ Remove	West Coal Lease Modification Drillhole log sheets at the back of Appendix 6-1 in Confidential Folder of MRP.
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	

Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	**Received by Oil, Gas & Mining**
	RECEIVED AUG 30 2010 DIV. OF OIL, GAS & MINING

CHAPTER 1

GENERAL CONTENTS

125 South 600 West
Price, Utah 84501

State of Utah
School and Institutional Trust Lands Administration
675 East 500 South, Suite 500
Salt Lake City, Utah 84102-2818

The Applicant owns 640 acres of coal within the ~~permit~~lease area. Surface ownership of these acres is listed below:

Neal J. Mortensen
c/o UNELCO, Inc.
Aurora, Utah 84620

Roger E. Nielsen and Ruth Nielsen
515 East 240 North
Salina, Utah 84654

Canyon Fuel Company, LLC
225 North 5th Street, 9th Floor
Grand Junction, CO 81501
Telephone: (970) 263-5130

A property ownership map of the permit area and adjacent area is presented as Plate 5-6.

No area within the lands to be affected by surface operations and facilities or within the area of coal to be mined is under a real estate contract.

Coal mining and reclamation operations are listed on Table 1-1 and the corporate structures is presented on Figure 1-1 in the General Chapter 1 binder.

112.600 Owners of Record of Property Contiguous to Proposed Permit Area

The following list contains the names and addresses of all owners of surface lands contiguous to the permit boundary:

United States of America
Department of Agriculture
U.S. Forest Service
Fishlake National Forest
115 East 900 North

The legal description of the SUFCO coal leases:

Federal Coal Lease U-28297 - (2,631.98 acres) - Approved January 1979
T. 21 S., R. 5 E., SLM, Utah
Sec. 32, lots 1-4, N1/2S1/2
Sec. 33, lot 1, NW1/4SW1/4
T. 22 S., R. 5 E., SLM, Utah
Sec. 4, lot 4, SW1/4NW1/4, W1/2SW1/4
Sec. 5, all;
Sec. 7, S1/2NE1 /4, E1/2SW1/4, SE1/4;
Sec. 8, all;
Sec. 17, NE1/4, N1/2NW1/4
Sec. 18, NE1/4, E1/2NW1/4

Federal Coal Lease U-062453 - (480 acres) - Approved March 1962
T. 21 S., R. 5 E., SLM, Utah
Sec. 28, SW1/4SW1/4
Sec. 29, SE1/4SE1/4
Sec. 32, N1/2
Sec. 33, W1/2NW1/4

Federal Coal Lease U-0149084 - (240 acres) - Approved June 1966
T. 22 S., R. 4 E., SLM, Utah
Sec. 12, NE1/4 and N1/2SE1/4

Federal Coal Lease SL-062583 - (~~2,202.77~~3,079.83 acres) - Approved September 1941
Modified January 1973
Modified December 2009
T. 21 S., R. 4 E., SLM, Utah
Sec. 36, S1/2
T. 21 S., R. 5 E., SLM, Utah
Sec. 31, all;
T. 22 S., R. 4 E., SLM, Utah
Sec. 1, lots 1 to 4 incl. S1/2N1/2, S1/2
Sec. 2, SE1/4, S1/2SW1/4;
Sec. 3, SE1/4SE1/4;
Sec. 10, E1/2NE1/4, NE1/4SE1/4;
Sec. 11, N1/2, N1/2S1/2;
Sec. 12, NW1/4
T. 22 S., R. 5 E., SLM, Utah
Sec. 6, all;
Sec. 7, N1/2NE1/4, E1/2NW1/4

Federal Coal Lease U-47080 - (~~1,158.05~~1,953.73 acres) - Approved October 1981
Modified December 2009
T. 21 S., R. 4 E., SLM, Utah
Sec. 25, all;

Sec. 35, E1/2, E1/2SW1/4;
Sec. 36, N1/2.
T. 21 S., R. 5 E., SLM, Utah
Sec. 30, lots 2-4, W1/2SE1/4
T. 22 S., R. 4 E., SLM, Utah
Sec. 2, lots 1-4, S1/2NE1/4, S1/2NW1/4, N1/2SW1/4;
Sec. 3, NE1/4SE1/4.

Federal Coal Lease U-63214 - (~~10,055.46~~10,695.46 acres) - Approved July 1989
Modified June 1999
Modified December 2009

T. 21 S., R. 4 E., SLM, Utah
Sec. 12, E1/2SE1/4
Sec. 13, E1/2NE1/4, S1/2
Sec. 14, E1/2SW1/4, SE1/4
Sec. 23, E1/2, E1/2W1/2
Sec. 24, all.
Sec. 26, E1/2, E1/2SW1/4;
Sec. 35, NW1/4, W1/2SW1/4.
T. 21 S., R. 5 E., SLM, Utah
Sec. 10, SE1/4NW1/4, E1/2SW1/4, E1/2E1/2SW1/4SW1/4,
E1/2E1/2NW1/4SW1/4, E1/2E1/2SW1/4NW1/4
Sec. 15, W1/2
Secs. 16-21, all;
Sec. 22, W1/2
Sec. 26, W1/2NW1/4SW1/4, SW1/4SW1/4
Sec. 27, all;
Sec. 28, N1/2, N1/2SW1/4, SE1/4SW1/4, SE1/4
Sec. 29, E1/2NE1/4, NE1/4SE1/4
Sec. 30, lot 1, N1/2NE1/4
Sec. 33, lots 2-4, NE1/4, E1/2NW1/4, NE1/4SW1/4, N1/2SE1/4
Sec. 34, all;
Sec. 35, lots 1, 2, W1/2NW1/4, N1/2SW1/4.
T. 22 S., R. 5 E., SLB&M, Utah
Sec. 3, lots 1-4, S1/2N1/2, NE1/4SW1/4, S1/2SW1/4, N1/2SE1/4,
SW1/4SE1/4
Sec. 4, lots 1, 2, S1/2NE1/4, SE1/4SE1/4
Sec. 9, NE1/4NE1/4
Sec. 10, W1/2NE1/4, NW1/4, N1/2SW1/4.

Federal Coal Lease UTU-76195 - (5,694.66 acres) - Approved October 1999
Modified December 2006

T. 21 S., R. 5 E., SLM
Sec. 2, lots 3,4, S1/2SW1/4, SW1/4SE1/4
Sec. 10, E1/2
Sec. 11, all
Sec. 12, S1/2SW1/4, NW1/4SW1/4
Sec. 13, NW1/4, S1/2

Sec. 14, all
Sec. 15, E1/2
Sec. 22, E1/2
Sec. 23-24, all
Sec. 25, N1/2, N1/2S1/2
Sec. 26, N1/2, NE1/4SW1/4, E1/2NW1/4SW1/4, SE1/4

T. 21 S., R. 6 E., SLM

Sec. 19, lots 3-4, E1/2SW1/4
Sec. 30, lots 1-3, E1/2NW1/4, NE1/4SW1/4

State of Utah Coal Lease ML 49443-OBA - (2,134.19 acres) - Approved October 2004

T. 21 S., R. 5 E., SLB&M

Sec. 4: Lots 1, 2, 3, 4, S1/2S1/2
Sec. 5: Lots 1, 2, 3, 4, S1/2S1/2
Sec. 7: Lots 2, 3, 4, S1/2NE1/4, SE1/4
Sec. 8: All
Sec. 9: All

Canyon Fuel Company, LLC acquired the right to entry on these properties in the merger described in Section 111 hereinabove.

In addition, the SUFCO Mine permit area includes certain fee lands owned by Canyon Fuel Company, LLC as follows:

T. 21 S., R. 5 E., SLB&M, Utah

Sec. 29, SW1/4, NW1/4, W1/2NE1/4, W1/2SE1/4
Sec. 30, S1/2NE1/4, E1/2SE1/4
containing 640.00 acres

T. 22 S., R. 4 E., SLB&M, Utah

Sec. 18, NW1/4NE1/4
containing 40 acres

The name of the owner of these fee lands changed from Coastal States Energy Company to Canyon Fuel Company, LLC as a result of the merger transaction described in Section 111 hereinabove.

The SUFCO Mine also uses certain Forest Service lands in its operation for a spring collection system, pumphouse, water transmission line, sanitary discharge line, sanitary drainfield, access road to the sediment pond, and 25 KV powerline. These USFS special use permit areas are shown on Plate 5-6 through portions of:

T. 22 S., R. 4 E., SLB&M, Utah

Sec. 12, S1/2
containing 15.32 acres

The name of the permittee changed from Southern Utah Fuel Company to Canyon Fuel Company, LLC pursuant to the merger described in Section 111 herein above.

The total lease area includes ~~22,462.92~~24,775.66 acres of Federal coal leases, 2,134.19 acres of State of Utah coal leases, 640 acres of fee coal leases, the 40 acres waste rock disposal site and 15.32 acres under U.S. Forest Service special use permit for a total of ~~25,292.43~~27,605.17 acres.

115 Status of Unsuitability Claims

To the best knowledge of Canyon Fuel Company, LLC, no portion of the area to be permitted is designated, or under study for being designated, unsuitable for mining.

Since the SUFCO Mine was in production before passage of the Surface Mining Control and Reclamation Act of 1977, the unsuitability criteria were not applied to the existing surface facilities.

Canyon Fuel Company, LLC does not propose to conduct coal mining or reclamation operations within 300 feet of any occupied dwelling. Coal mining and reclamation operations have been or will be conducted within 100 feet of a public road, see Section 5.2.1.1 for details. Forest Service approval to conduct coal mining and reclamation operations within 100 feet of the Link Canyon forest service road is located in Appendix 1-1 and the newspaper advertisement for public comment is located in Appendix 1-3.

116 Permit Term

The following information is presented to identify permit term requirements and stipulations. Canyon Fuel Company will be operating the SUFCO Mine with continuous miner and longwall mining methods. Although the Mining and Reclamation Permit Application covers the next five-year period of mining, information is presented below for the life of the mining operation.

1.	First coal produced	1941
2.	Termination of mining activity	December, 2016
3.	Horizontal extent of mine workings	~~25,292.43~~27,605.17 acres (Life of mine)

4. Vertical extent of mine workings — Surface to 2,000 feet deep (Life of mine)

The anticipated total acreage to be affected during the five years of operation by underground mining activities is 1,500 acres. The estimated number of total surface acres to be affected over the entire mining operation is 48.432 acres.

PERMITTED DISTURBED AREA BOUNDARY	ACTUAL AREA CURRENTLY DISTURBED TO BE RECLAIMED	SITE DESCRIPTION
30.210	17.405	Mine Site, East Spring Canyon
0.286	0.017	3 East Portals
1.774	0.70	4 East Portals
0.302	0.017	South Portals
0.396	0.017	Quitchupah Portals
0.967	0.39	Spring Collection Field, Convulsion Canyon
0.220	0.075	Pump House, Convulsion Canyon
0.784	0.40	Leach Field, Convulsion Canyon
1.595	0.193	Water Tank, East Spring Canyon
0.287	0.18	Link Canyon Substation No. 1
0.245	0.12	Link Canyon Substation No. 2
0.380	0.18	Link Canyon Portal
10.986	8.733	Waste Rock Disposal Site
0.000	0.00	North Water Mitigation Area
0.000	0.00	Quitchupah Fan and Shaft Site
48.432	28.427	Totals

The permit area boundary, which is shown on Plate 5-6, ~~the same as the lease area legal descriptions in Section 114,~~ includes portions ~~22,462.92 acres~~ of Federal coal leases, ~~2,134.19 acres of State of Utah coal leases, 640 acres of~~ fee coal leases, the ~~40 acres~~ waste rock disposal site and ~~15.32 acres under~~ U.S. Forest Service special use permit areas for a total of ~~25,292.43~~720.483 acres.

117 Insurance and Proof of Publication

CHAPTER 3

BIOLOGY

LIST OF PLATES

Plate

LIST OF APPENDICES

(Appendices appear in Volume 5)

Appendix

through 3.2.2.3 and in the "Muddy Creek Summary Report - Wildlife" prepared by Cirrus and included as Appendix 3-11. Fish and wildlife resources within the West Coal Lease Modifications are summarized in Appendix 3-13. A description of the potential impacts and mitigation of impacts of mining on fish and wildlife is included in Section 3.3.3.3 of this permit.

Due to either their small size, intermittent flows, poor habitat or water quality, the surface waters in the lease area are not of game fish quality. The low importance of the streams as a fishery resource, has categorized them as being of little value for extensive study. An inventory of the aquatic resources is located in Appendix 3-2. Aquatic resources of the Pines Tract Project are briefly described in the wildlife section of Appendix 3-9. Aquatic resources within the Muddy Tract are summarized in Appendix 3-11. Aquatic resources within the West Coal Lease Modifications are summarized in Appendix 3-13.

3.2.2.1 Level of Detail

The scope and level of detail within this M&RP are sufficient to design the protection and enhancement plan for wildlife and fish in the area.

This assessment of wildlife resources has been compiled pursuant to guidelines issued by the State of Utah Division of Oil, Gas and Mining (UDOGM). Appendices 3-3, 3-4, 3-5, and 3-9 contain wildlife studies related to their resources in the mine area.

3.2.2.2 Site-specific Resource Information

The following information was summarized from the WIL, RAP, AQU, and VWP Reports. Additional information is available in Appendix 3-2 through 3-5, and 3-9.

Reptiles and Amphibians

Increasing elevation rapidly reduces the number and kind of reptiles and amphibians. Furthermore, in Utah the effects of the more northern latitude reduces the number of reptiles in much the same way as does the increase in elevation.

These geographical and associated climatic factors have eliminated most desert species, leaving species that are adapted either to mountain habitats or montane type habitats developed in the more northern areas.

Literature pertaining to the amphibians and reptiles is extensive; but, much of it refers to species occurring in the desert areas and has only limited reference to forms inhabiting Utah mountains.

Based on the extensive literature review and limited field work it was determined that potentially 8 species of amphibians (Appendix 3-5) inhabit the area of concern which provides substantial value habitat . All amphibians are legally protected, but since the species listed are all widespread throughout the mountains of Utah, none are treated as high-interest species. It is doubtful that the proposed action would seriously impact populations, but localized individuals may be involve in habitat destruction due to subsidence. An exception to this would be if subsidence interrupted underground aquifers and caused drying of present wet habitats essential to reproduction.

Based on the literature search and limited field work, it was determined that potentially 14 species of reptiles (Appendix 3-5) occupy the mine land area, a substantial value habitat for all species. All reptiles are legally protected but since the species listed are all widespread throughout montane habitats in Utah, none are treated as high-interest species and, therefore, are not individually discussed. It is doubtful that the proposed action would seriously impact populations.

Information about reptiles and amphibians specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). Information about reptiles and amphibians specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). Information about reptiles and amphibians specific to the West Coal Lease Modifications are summarized in Appendix 3-13.

Wetlands and riparian areas exist within the permit area and have been estimated to represent less than one percent of the total acreage within Pines Tract Project Area and SITLA Muddy Tract. These areas are supported by streams, springs, and seeps located throughout the drainages. Studies in the semi-arid West comparing riparian areas with adjacent uplands showed that riparian zones support up to 400 percent more plant biomass, up to 200 percent more species, and contribute to large increases in density and species richness for birds when compared to upland areas.

Between 69% to 92% of all amphibian occur in wetland ecosystems. The scaleless, permeable amphibian skin requires constant moisture to retain body fluids. Both water quantity and quality parameters are of importance to the survival of individual amphibians and ultimately populations of the species.

Reptiles are not nearly as dependent on wetlands since their scaly covering provide resistance to desiccation. Riparian areas are heavily utilized (50% to 72% of all species) for the available drinking water, prey, and vegetative resource (cover). The moist soil characteristic of riparian zones also provide preferred nesting habitat for many reptiles.

The riparian areas for the Pines tract Project Area, Link Canyon, and SITLA Muddy Tract are shown on Plate 3-1. A survey for amphibians and mollusks was conducted in the Link Canyon Portal area in June of 2002. No amphibians or mollusks where found in the portal area nor where any protected or sensitive species found in the area. A copy of a report of the investigation is contained in Appendix 2-9.

Raptors

Only one nest, that of a Cooper's Hawk, was found in 1980 (Appendix 3-4). The one Cooper's Hawk nest found was in an area seemingly less favorable than surrounding canyons. Quitchupah Canyon appeared to be prime habitat, but no nests were found.

Golden Eagles were seen on nearly every survey day during the 1980 survey by Clayton White of Brigham Young University (Appendix 3-4). The presence of two adults accompanied by a juvenile suggest their nearby breeding, however no nests were located.

Appendix 3-4, Table 1 contains a list and the number of sightings for the birds inventoried during the 1980 raptor survey.

A raptor survey conducted April 14, 1987, located three Golden Eagle nests (Appendix 3-4). Two of the nests were tended and contained greenery, the third had an adult eagle incubating eggs.

In October of 1988 an environmental assessment of the Quitchupah Lease area was performed by personnel from the Forest Service and Bureau of Land Management. During the assessment 6 Golden Eagle nests were located.

The SUFCO Mine portions of the annual raptor surveys conducted by UDWR are located in Appendix 3-4 in the Sufco Mine MRP Confidential file. Future annual raptor surveys will be submitted each year in the annual report to the Division.

Most raptor nest locations are located outside the current planned mining subsidence areas. Any raptor nest that has a potential to be disturbed by subsidence will be evaluated with DWR and FWS. An appropriate plan of action will be developed on a case by case basis.

The Prairie Falcon has also been reported by U.S. Forest Service and Bureau of Land Management personnel for the planning unit that encompasses the SUFCO Mine area.

The Quitchupah Drainage, of which Link Canyon is a tributary, was identified in the Quitchupah Creek Road DEIS (2001) as not likely to contain Mexican Spotted Owls and dedicated surveys were not necessary. However, the Manti-La Sal National Forest reported that a Mexican Spotted Owl survey of the area was being conducted as part of their Muddy Creek EIS Data Adequacy study. Results of surveys conducted in 2002 and 2003 indicated no Mexican Spotted Owls were found in the Link Canyon Portal area or the Muddy Tract area (Appendix 3-12). Additionally, Sufco does not plan to conduct construction activities during the nesting and rearing times (February 1 through August 31) of the owl.

The lack of permanently running water has an effect on raptors. Many species, such as accipiters, appear to rely on streams and the associated riparian vegetation (Hennessy, 1978).

Any area with suitable habitat where raptor nests could be adversely affected by subsidence will be monitored during the year that it will be subsided for both known and potential new nests on a yearly basis using aerial or ground surveys near the end of May. Known raptor nests are shown on Plate 3-3.

Information about raptors specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). Information about raptors specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). Information about raptors specific to the West Coal Lease Modifications are summarized in Appendix 3-13.

Elk

The elk herd (#14) is a significant wildlife resource to the citizens of Utah and there is considerable hunting pressure. Winter and summer range is in generally good conditions, but drought is an immediate concern (Big Game Annual Report, 1991).

Although the potential area of impact is not critical to the continued existence and perpetuation of the herd, it is important to maintenance of current population levels, and portions of the entire lease area are used annually on a seasonal basis. The aspen areas of Duncan Mountain serve as calving areas for the small herd, (10-20 animals observed during the 1980 summer in that area) but based on pellet counts (WIL, Table 7) the major portion of the lease area is utilized in late fall, winter, and early spring.

In May, while there was still snow on the ground, considerable fresh elk sign (pellets and tracks) was found around the Acord Lakes. By June 5, 1980, when access was available to the other areas, elk tracks were concentrated in the ponderosa, mahogany, aspen and manzanita communities along the ridges and rims of the canyon, plus in the canyons such as Duncan's Draw and Lizonbee Springs. During the summer the elk and elk signs were sighted near the top of Duncan Mountain and at the head of the South Fork of Quitchupah. It seems that the elk in question do not always winter on the rims nor the plateau but in the lower elevation areas to the southeast. This observation was substantiated by a conversation with a local forest ranger out of

Richfield. The amount of snow is probably the determinant, with the elk wintering wherever there is available forage from the rim to the low brush areas in the southeast.

The fact that elk utilize the entire area of concern during some time of the year means that all aspects and timing of the actions must be considered. However, since the SUFCO Mine has been operational since the early 1940's and since there are no plans for additional surface facilities other than ventilation portals along the cliffs, there should be little additional disturbance to the elk. The animals have already accommodated the human disturbance associated with the mining and hauling of coal.

Information about elk winter-range and migration routes specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). Information about elk winter-range and migration specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). Information about elk winter-range and migration specific to the West Coal Lease Modifications are summarized in Appendix 3-13.

Mule Deer

Mule deer on the mine area are considered part of Herd Unit 43 by the UDWR. The animals in the environs of concern utilize the entire assessment area but seasonally concentrate in and more heavily utilize specific habitat types.

During the summer the mule deer generally utilize all of the habitats near watering areas. The most heavily used communities were the sage, mountain brush and the composite of aspen, mountain mahogany, manzanita and ponderosa. This is as expected since there is considerably more browse in these communities than in the others sampled.

With the onset of fall and winter the mule deer latitudinally migrate. Initially (late fall and early winter) they concentrate on the plateau area where they intermingle with the elk but when the snow gets too deep for them to traverse they move into the low elevation sage, and pinyon juniper areas to the southwest. The wintering areas for mule deer make them susceptible to road strikes in the vicinity of the haul and access road for the SUFCO Mine and Interstate 70.

Information about mule deer winter-range and migration routes specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). Information about mule deer winter-range and migration specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). Information about mule deer winter-range and migration specific to the West Coal Lease Modifications are summarized in Appendix 3-13.

Cougar

The entire SUFCO Mine area provides substantial value, and yearlong habitat for cougar. The animal ranges throughout the area as evidenced by a sighting one third of the way down the slope in Quitchupah Canyon, one half mile below the confluence of South Fork, and tracks in the mud near Jack Adley's Monument, Broad Hollow, and in the dust of the road near Acord Lakes. Though animals range throughout the area, their movements are often dictated by migration patterns of their primary food source (mule deer) and human disturbance. Concern must be given to the cougars particularly when the females are accompanied by their young who are learning to hunt and survive. This is considered a sensitive period for cougars and it is best if disturbance is minimized during this time. However, this period in their life cycle is difficult to determine for cougars since they are known to reproduce year round.

Bobcat

The mine and adjacent areas provide substantial value habitats for bobcats, who were evidenced, by sightings and tracks, to occupy or use all terrestrial habitats on the entire area of potential impact. Sensitive periods would be late February when parturition occurs, May and June when young bobcats are first exploring and learning to hunt. Bobcats are not as secretive as cougar, making them less likely to avoid the high human disturbance areas and making them more vulnerable to open human harassment and illegal killing. Since this is an ongoing mining operation, pressures on bobcats should be unchanged.

Black Bear

Bear tracks were observed in Broad Hollow, but Forest Service personnel indicated to us that most of the bear sightings occurred on White Mountain. At best black bear are not abundant nor are they active year round. Sensitive periods in the life cycle of the black bear are February and March when the cubs are born and when they accompany their mother on initial foraging expeditions during early summer. Since parturition occurs within the winter den and since disturbance in the black bear habitat will be limited to subsidence, this sensitive period will be little impacted by the proposed action.

Mountain Cottontail

The entire mine area provides substantial value, and yearlong habitats for cottontail rabbits. The young are born between April and July which is considered a sensitive period, but the proposed actions will in all probability not seriously alter the reproductive potential of the population. Hunting pressure will likely not increase, nor will illegal kills. However, this would not matter since hunted rabbit populations are more healthy and stable than non-hunted populations. Subsidence could potentially cause death from caving burrows and disrupt reproduction for a short time.

Snowshoe Hare

The snowshoe hare is present in and dependent upon the limited spruce-fir vegetation habitat of the mine area year round. The sensitive period for reproduction is from April 1 to August 15. Subsidence will not impact the above ground dweller as it does subterranean inhabitants. Little change in snowshoe hare populations will result from the proposed actions. Hunting pressure, legal and illegal, will be the most influential activity of man upon snowshoe hares, but will be of little far reaching impact.

Fur bearers

Limited portions of the mine and adjacent areas provide substantial value habitats for a few species categorized by management agencies as fur bearers: ermine, long-tailed weasel, badger and the striped skunk. The breeding and rearing activities of these non-migratory species occurs within the area and their dens and burrow systems are important to maintenance of their populations, but it is unlikely that the proposed actions will seriously impact them for any length of time. Subsidence will be localized and new burrows will be built or old ones reconstructed after it occurs. These species are widespread and adaptable to the activities of man.

Small Mammals

Small mammals represent a significant part of the ecosystem. The majority are herbivores and are the primary source of food for higher trophic levels, particularly raptorial birds, canids and felids. The potential exists for caving burrows in and/or changing burrow continuity due to fracturing of the strata. Should this occur, it is likely that young mammals in the nest would be crushed or cut off from parental care. Although this would temporarily alter the population density and age structure, recovery would be imminent and rapid. The 1997 Bat Survey for the SUFCO Mine conducted by J. Mark Perkins & Joshua R. Peterson is included in Appendix 3-8.

Information about small mammals specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). General information about small mammals specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). General information about small mammals specific to the West Coal Lease Modifications are summarized in Appendix 3-13.

Threatened and Endangered Plant and Wildlife Species. Passage of the Endangered Species Act of 1973 (Public Law 23-20S) provided the legal basis for establishment of lists of endangered and threatened plant species. Such lists were prepared under direction of the Smithsonian Institution, and were published subsequently in the Federal Register (40: 2782 427924, 1975; and 41: 2452 4 24572, 1976). The region under investigation was included in a report on threatened and endangered species of the Central Coal lands of Utah (Welsh 1976). An inventory of endangered wildlife species performed in 1989 by the Division of Wildlife Resources recorded no species within the proposed permit area (conversation with Pamela Hill, DWR, Cedar City, 1991). Table 3-1 provides a list of Federally listed Threatened and Endangered Species that have been identified in the Utah counties in which Sufco lies. However, this list does not necessarily indicate these species are found within the mine permit boundaries.

A survey of the literature has failed to indicate the presence of any endangered or threatened plant species in the area. This lack of critical or unique species is supported by the field surveys of the lease areas. The region was searched by walking parallel transects on a quarter-section by quarter-section basis, with each community type within each quarter-section being traversed. No endangered or threatened species were encountered in the lease area or in the adjacent areas.

There are no federally listed threatened or endangered fish species inhabiting the aquatic habitat.

A discussion about threatened, endangered or otherwise sensitive plant and animal species of the Pines Tract Project area is given in Appendix 3-9. A discussion about threatened, endangered or otherwise sensitive plant and animal species of the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). A discussion about threatened, endangered or otherwise sensitive plant and animal species of the West Coal Lease Modifications are summarized in Appendix 3-13.

Construction associated with the reopening of the western Link Canyon Mine portal, will require minimizing activities that disturb big game from December 1 to April 15. Construction activities from January 1 to August 15 will require a clearance from the DWR and US Fish and Wildlife Service because of potential disturbance to nesting raptors. This proposed project is located in a MMA (Minerals Management Area) in the Manti-La Sal forest plan (Figure 3-15, Management Area Direction, Manti-La Sal National Forest Pines Tract Project, Final Environmental Impact Statement, January 1999). A GWR (General Big-Game Winter Range) Management Unit is located adjacent to the MMA Management Unit. Although this direction does not apply to the adjacent MMA Management Unit where the current proposal is located, the Manti-La Sal National Forest Record of Decision considered this management direction. Direction for operations in adjacent GWR Management Units calls for minimizing potential conflicts. The current proposal will have negligible effects to wintering big game because there will be very little activity at the site following the initial short-term construction activity (pages 14-15, Manti-La Sal National Forest, SUFCO Mine Link Canyon Portal Record of Decision, Oct. 10, 2002). The area will be surveyed for raptor nests. If any are found within the prescribed buffer zone, they will be monitored for activity and work at the portal site will occur following the same guidelines as those described for the Link Canyon Substation.

Mining within the SITLA Muddy Tract will be limited to underground activities; no surface disturbance, other than exploration drilling, is anticipated in this area. Exploration drilling is typically handled by the Division under a separate permit application process. No known raptor nests are known to exist within the SITLA Muddy tract where subsidence will occur. However, if future raptor monitoring finds any raptor nest that has a potential to be disturbed by subsidence, the nest and potential damage will be evaluated with DWR and FWS. An appropriate plan of action will be developed on a case by case basis. The Division of Oil Gas and Mining will be informed in advance when such an evaluation is necessary. The applicant will obtain any permits necessary for disturbance of the nest if this is the course of action decided upon.

Generally, vegetation within the lease and permit areas outside of disturbed areas is protected from mining related impacts, such as subsidence, by the depth of overburden and depth of soil. Experience in mining the Pines and Quitchupah leases has shown that upland vegetation does not appear to be significantly affected by subsidence. Cracks that form in the soil tend to heal quickly

CHAPTER 4

LAND USE AND AIR QUALITY

CHAPTER 4

LAND USE AND AIR QUALITY

4.10 Land Use

This section of the permit application includes descriptions of the premining and proposed postmining land use(s).

4.1.1 Environmental Description

A statement of the conditions and capabilities of the land to be affected by coal mining and reclamation operations follows in this section.

4.1.1.1 Premining Land Use

The surface lands within the lease and permit areas (except for 640 acres privately owned) are owned by the U.S. Government and are either parts of the Fishlake National Forest, the Manti-La Sal National Forest or lands administered by the Bureau of Land Management. These lands have been inventoried by the respective regulatory agencies who are responsible for the administration and use of these government lands. Federal comprehensive land use plans have been prepared by the U.S. Forest Service Offices.

Land Use Map. Plates 4-1A & 4-1B presents these Federal comprehensive land use plans information in the permit area.

Land Capability. The SUFCO Mine area's recreational use (excluding hunting) is approximately 427 days annually. Most of this use is dispersed among horseback riding, snowmobiling, hiking, camping, four wheeling and fuel wood gathering (Billy Dye, Ferron Ranger District; Bob Tuttle, Fishlake National Forest).

The major plant communities in the SUFCO Mine area are identified in Section 3.2.1.1.

"The mesa rim and deep canyons can be seen as background from Emery (Dog Valley). They are classified as distinctive with variety. Activity from the proposal will not be visually evident from the valley. The lease area is seen as middle ground from a few remote spots on the Duncan Mountain Road. This scene area is presently classified in Sensitivity Level 2 (Average Sensitivity). The visual objective as recommended by the Land Use Plan is 2 (Modification). This permits activities to visually dominate the characteristic landscape. Very few people visit the area and those that do, come for something other than scenic attractions."

With the inclusion of the Pines Tract into the SUFCO lease and permit areas "changes in the existing landscape could include escarpment failures. This is not expected to change the visual character of the region."

A portion of the surface area is grazed by cattle under the Quitchupah Grazing Association allotment (Fishlake National Forest). The allotment covers approximately 43,156 acres, it presently supports 813 head of cattle from June 11 through September 30, for a total of 2,981 cow months (Bob Tuttle, Fishlake National Forest).

The Emery allotment (Manti-La Sal Forest) supports 1,300 head of cattle. This allotment is under an intensive rest-rotation management system, placing the cattle in the mine area for approximately one month a year. Several ranches in Emery County are dependent on the allotment. Structural range improvements include one watering trough (spring fed) and two cattle guards on the access route into the lease.

The number of hunters in the Salina Planning Unit increased 122 percent from 1969 to 1972 (U.S. Forest Service, 1976). In Deer Unit #43/45 (Salina) 9,383 hunters were recorded afield during the 1990 hunting season. The Fishlake Elk Herd Unit #14 hosted 4,027 hunters during the 1990 season. Additional hunter use information reported by the Utah Division of Wildlife Resources can be found in the Utah Big Game Annual Report for 1991 (Appendix 4-1).

The Applicant agrees, however, to notify the regulatory authority and the Utah State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of mining operations. The Applicant also agrees to have any such cultural resources evaluated in terms of National Register of Historic Places eligibility criteria.

West Coal Lease Modification Areas

Cultural and Historic Information. Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2 in the Confidential folder of the M&RP. EarthTouch, Inc. conducted an intensive evaluation of the West Coal Lease Modification Areas.

The results of the cultural resource inventory for the project resulted in the identification of 15 cultural resource sites, which included three previously recorded sites (42SV1301, 42SV1386 and 42SV2688), and 12 new sites (42SV3207-3215 and 42SV3246-3248). Overall, the identified cultural resource sites consist of small- to moderate-sized lithic scatters and small rock shelters/overhangs, some with associated pictographs. Of the 15 sites identified within the West Coal Lease Modification Areas, six sites are recommended eligible for the National Register of Historic Places. These sites include 42SV3209, 42SV3211, 42SV3212, 42SV3213, 42SV3247 and 42SV3248 which consist of small rock shelters and rock shelters with pictographs. Site 42SV3209 will be the only site undermined under the present mine plan. This shelter is more of a terrace overhang that extends 6 meters long, with a 1.5 meter overhang or width.

The Applicant agrees, however, to notify the regulatory authority and the Utah State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of mining operations. The Applicant also agrees to have any such cultural resources evaluated in terms of National Register of Historic Places eligibility criteria.

4.1.1.2 Previous Mining Activity

Portions of the mine plan area were mined prior to the filing of this permit application. SUFCO Mine began a small operation mining the Upper Hiawatha Coal seam in 1941. There was no previous mining activity prior to the 1941 SUFCO operation.

From 1941 through 1974, the coal was removed by conventional mining techniques. From 1974 through 1978, both conventional and continuous mining methods were used. From 1978 until October 1985, all mining used continuous mining methods. Since October 1985 both continuous mining and longwall mining methods have been used. The portion of the seam mined by conventional methods was only partially extracted leaving all pillars for support. The majority of the mining done has been full extraction. All longwall mining is full extraction.

The quantity of coal mined prior to this permit application was approximately 37,058,100 tons. The earlier workings are shown on Plate 5-1 as an integral part of the mining operation.

Use of the land preceding mining was primarily grazing. The area also supported limited timbering in the Ponderosa stands and hunting.

4.1.2 Reclamation Plan

4.1.2.1 Postmining Land Use Plan

All uses of the land immediately prior to mining and the capability of the land to support prior alternate uses will remain equally available throughout the life of the mine without impact from underground mining except on insignificant levels. The infinitesimal effect of underground mining on surface use is accounted for as follows:

1. Isolated facilities in use for duration of the mine, including portal and associated buildings, comprise only ~~46.233~~48.432 of the ~~26,767.14~~27,605.17 acres under consideration, which is too small to adversely affect general land use.

2. Gradual and even subsidence over most of the lease and permit areas is too imperceptible to affect general land use. The ultimate subsidence affect over the lease will be "uniform." As a qualification, there probably will be an uneven arching effect on the surface over the full-extraction mining areas during actual mining operations which will stabilize in uniform subsidence once the entire area has been mined. The total subsidence effect should be minor so as to not affect general land use.

The Applicant intends that the postmining land uses will be consistent with the land use plans prepared by the Forest Service. Final reclamation activities such as grading and seeding as detailed within this M&RP will be completed in a manner to provide uses of the lands consistent with those uses required by the U.S. Forest Service land use plans. Retention of pre-SMCRA highwalls is discussed in Section 5.5.3.6.

The SUFCO Mine lease areas are predominantly U.S. Forest Service land managed under the multiple use and sustained yield concepts. Present management emphasizes livestock grazing, wildlife, timber and watershed development.

CHAPTER 5

ENGINEERING

LIST OF PLATES

LIST OF APPENDICES

(Appendices appear in Volume 6)

LIST OF APPENDICES
(Appendices appear in Volume 6)

allotments during seasonal changes. SUFCO Mine also uses portions of this road to access the mining operation's electrical and water supply systems. Mining activities are conducted within 100 feet of this road during maintenance and operation of the electrical substation and water supply system (adjacent to the road) and where the portals enter the ground (beneath the road). The interests of the public and the affected landowners will be protected with respect to this road by the following measures:

- No subsidence or caving operations will be conducted to affect any portion of the right-of-way of this road within 100 feet of the underground entry system,
- Surface activities will be conducted in a manner that will not block the road, and
- Water bars have been constructed on that portion of the road bordering the disturbed area adjacent to the mine surface facilities. Regular inspections of that portion of the road are conducted by mine personnel to ensure that erosion does not become a problem. In the event that material damage due to erosion as a result of mining activities is discovered on or along the side of this road, SUFCO Mine will repair this damage and implement additional runoff-control measures as needed.

Subsidence from underground mining operations may affect public-access dirt roads throughout the lease and permit areas . As part of the subsidence monitoring program, these roads will be regularly inspected. If material damage occurs to these roads as a result of mine subsidence, the roads will be repaired by SUFCO Mine.

Mining Sequence and Planned Subsidence. The mine plan for the SUFCO Mine is presented in Plate 5-7 (Upper Hiawatha seam) and Plate 5-8 (Lower Hiawatha seam). These maps show the boundaries of all areas proposed to be affected over the estimated total life of the coal mining and reclamation operations, including the size, sequence, and timing of mining of subareas to be affected beyond the present permit term. No surface disturbances are currently anticipated within the permit area beyond that presented in this M&RP.

Plates 5-7 and 5-8 also shows the location and extent of underground workings in which planned-subsidence mining methods will be used as well as areas where measures will be taken to prevent,

Topsoil Markers. Markers have been placed on all topsoil stockpiles. These markers are labeled "Topsoil Storage Area".

5.2.2 Coal Recovery

Current mining operations at the SUFCO Mine occur in the Upper Hiawatha Seam. Future mining operations are also planned to occur in the Lower Hiawatha Seam. The overall objective of mining operations in the lease and permit areas is to maximum coal recovery coupled with safety. Coal recovery at the mine has been and will continue to be maximized through the following efforts:

- Pre-mining analysis of drill-hole data allows estimates to be made of the nature, depth, and thickness of the coal seam and associated partings. Using these data, the mine plan and mining methods are evaluated and amended as necessary to maximize coal recovery.
- Experience gained during mining is used to amend future mine plans if coal recovery can be increased.
- The mine converted from an exclusive room-and-pillar extraction method to a combination of room-and-pillar and longwall extraction methods in October 1985. As a result of this conversion, coal recovery at the mine increased from approximately 75 percent under exclusive room-and-pillar methods to 88 percent under the combined room-and-pillar and longwall methods.

The mine layout has been planned relative to panels, barriers, and pillars to optimize both coal recovery and safety using a combination of longwall and room-and-pillar mining techniques.

An evaluation of geologic data collected in the southern portion of lease U-28297 indicates that the Upper Hiawatha seam in this area contains a paleochannel system and associated parting. The parting attains a thickness in excess of 20 feet and occurs in a northeast-southwest trending band varying in width from 2,000 feet to 7,500 feet. Because of this parting, most of the southern portion of lease U-28297 is deemed unminable from both technological and economic viewpoints.

Mining is not planned on the extreme east and southeast portions of the Pines Tract Lease UTU-76195 as a result of poor quality and seam height. A parting located in the middle of the seam, will not allow mining to occur at the minimum height without putting quality at unacceptable levels. Much of the seam height in these areas is between 4-6 feet. Reserves are also lost to burn in these areas as a result of several promontories in the area which allow greater exposure of the outcrop to the atmosphere.

Mining is not planned on the northern portion of the SITLA Muddy Tract Lease ML 49443-OBA in the Upper Hiawatha Seam as a result of a sand channel and seam height that will not allow mining to occur.

The Lower Hiawatha seam will be mined in the northwest portion of the lease~~permit~~ area where the interburden thickness between the Upper and Lower Hiawatha seams exceeds 30 feet. The mine plans are columnized or stacked where both seams are to be extracted. The Duncan seam does not contain sufficient minable reserves to warrant mining within the lease~~permit~~ area.

The Duncan seam occurs about 100 to 130 feet above the Upper Hiawatha seam in a small portion of lease U-28297. The unsplit area of the Duncan seam is of small extent, probably less than 50 acres. Federal Lease U-28297 grants ~~Coastal States Energy Company's~~Canyon Fuel Company, LLC SUFCO Mine only the right to mine the Upper Hiawatha seam.

The Quitchupah Tract Resource Recovery and Protection Plan (R2P2) for ~~Coastal States Energy Company's~~Canyon Fuel Company, LLC SUFCO Mine is on file with the Bureau of Land Management. The R2P2 contains detailed mine plan and reserve calculations for all of the Quitchupah Tract leases operated by ~~Southern Utah Fuel Company~~Canyon Fuel Company, LLC SUFCO Mine.

The Pines Tract Resource Recovery and Protection Plan (R2P2) for Canyon Fuel Company, LLC SUFCO Mine is on file with the Bureau of Land Management. The R2P2 contains detailed mine plan and reserve calculations for the Pines Tract lease operated by Canyon Fuel Company, LLC SUFCO Mine.

The SITLA Muddy Tract Plan of Operations Resource Recovery and Protection Plan (R2P2) for Canyon Fuel Company, LLC SUFCO Mine is on file with the State of Utah, School and Institutional Trust Lands Administration. The Plan of Operations Resource Recovery and Protection Plan (R2P2) contains detailed mine plan and reserve calculations for the SITLA Muddy Tract lease operated by Canyon Fuel Company, LLC SUFCO Mine.

5.2.3 Mining Methods

A combination of room-and-pillar and longwall mining methods are used in the SUFCO Mine. The use of these two mining methods has been selected to maximize coal recovery and enhance production rates within the specific geologic constraints of the lease~~permit~~ area.

Several draw angle surveys have been performed at the mine over the past fourteen years. These surveys have been oriented both parallel and perpendicular to the long axis of the panel. Data collected over continuous-miner areas to date indicate that the average draw angle is 15 degrees. Individual measurements over continuous-miner areas have ranged from 10 to 21 degrees. New longwall draw angle data obtained in 1995 indicates an angle of 15 degrees for the longwall areas. Draw angle study completed in 1999 over 13L4E LW panel indicates 15 degrees is valid. Summary results of the LW panel studies are shown in Figures 5-0A and 5-0B.

Tension cracks have occurred over most of the subsidence areas. These cracks tend to be most pronounced in areas where pillars have been extracted (as compared to areas overlying longwall panels). The lengths of the cracks vary from a few feet to nearly 200 feet. Most are oriented either parallel to the natural jointing pattern or parallel to the boundaries of the underground excavation. Cracks with the longest continuous length appear to be natural joints which have been intensified by subsidence action. Vertical displacement along the cracks is uncommon and horizontal displacement varies from hairline to several inches in width. Follow-up observations of individual tension cracks indicate that the cracks tend to close (either partially or fully) following initial development (see Appendix 5-4).

Monitoring data collected to date indicate that subsidence above the SUFCO Mine occurs rapidly after initial movement. Approximately 80 percent of maximum subsidence occurs within about four months. The remainder of subsidence occurs slowly over a period of a few years. These monitoring data have been presented and summarized annually in reports submitted to the UDOGM by SUFCO Mine.

5.2.5.1 Subsidence Control Plan

Potential Areas of Subsidence. Structures that are present above the existing or planned mine workings that may be affected by mining are shown on Plate 5-5. Renewable resource lands within the lease and permit areas are shown on Plate 4-1.

Mining Methods. As noted in Section 5.2.3, both room-and-pillar and longwall mining methods are used in the SUFCO Mine. The size, sequence, and timing for the development of the underground workings are shown on Plates 5-7 and 5-8.

Physical Conditions Affecting Subsidence. A detailed description of the physical conditions in the lease and permit areas that influence subsidence (i.e., overburden lithology and thickness, coal seam thickness, etc.) is provided in Chapter 6.

Subsidence Control Measures. Most of the land within the lease~~permit~~ area will eventually be affected by subsidence. Anticipated areas of subsidence and those areas planned for protection from subsidence are shown on Plates 5-10A, ~~&~~ 5-10B & 5-10C. The primary areas where subsidence is not anticipated are the areas overlying the pre-1977 workings in Lease SL-062583 shown on Plate 5-1 (referred to herein as the "Old Mine") and certain lease areas underlying Quitchupah Canyon, Box Canyon, and Muddy Creek.

The "Old Mine" area was mined in such a manner that coal pillars were left for support throughout the entire workings. Since these pillars are large enough to support the overburden and further mining is not anticipated in these workings, the surface area above the workings should not experience any subsidence.

Where perennial streams are not undermined they will be protected from subsidence by establishing stream buffer corridors within the mine from which only limited coal recovery will occur. Support pillars will be left in these locations to preclude subsidence. Underground stream buffers will only be crossed to the extent necessary to allow access to reserves. This access will consist of entries and cross cuts with support pillars. Entries that cross through the underground stream buffer corridors with less than 300 feet of cover will be sealed and/or backfilled upon abandonment using the best available technology to prevent disturbance of the overlying streams.

Protected cultural resource sites (see Plates 5-10AC, ~~&~~ 5-10BC & 5-10CC located in the Sufco Mine MRP Confidential file) will be designed to include a buffer zone to protect the area from the effects of subsidence caused by underground full extraction mining. The width of the corridor will be calculated as follows: the depth of overburden to the coal seam will first be established. This depth will be multiplied by tan 15° to obtain the distance underground mining needs to be away from the area to not cause subsidence effects. An additional 25 foot buffer will be added to this calculated distance to account for minor irregularities in the course of the stream or cultural resource site.

Surface structures overlying the area to be subsided consist of trails, unimproved dirt roads, fences, runoff catchment ponds, and streams. The applicant will repair any subsidence caused damage to these or other structures to the extent economically and technically feasible, and will comply with R645-301-525.160 and R645-301-525.230. Additional mediation and remedial measures are described in Section 5.2.5.2 Subsidence Control.

Monitoring within the lease~~permit~~ area has shown that subsidence rarely exceeds 50 percent of the mining height where the overburden thickness is greater than 800 feet. This overburden thickness is generally achieved above the rim of the Castlegate Sandstone (see Plates 5-10A, ~~&~~ 5-10B & 5-10C). Topography above the Castlegate Sandstone is gently sloping while that within and below the sandstone outcrop contains cliffs and steep slopes. With the exception of the experimental mining practice described below, future subsidence is typically planned only for those areas above the rim of the Castlegate Sandstone where the overburden thickness exceeds 800 feet.

Experimental Mining and Subsidence. To protect the environmental resources associated with escarpments, SUFCO Mine currently has a general policy of precluding subsidence below the rim of the Castlegate Sandstone. This requires that significant quantities of coal remain unrecovered.

Pillars were extracted from room-and-pillar workings beneath two areas of escarpment. The location of these areas is shown on Plate 5-1. These areas involved a 5,000-foot section of escarpment on Federal lease (SL-062583) in East Spring Canyon (1977-78) and 2,000 feet of escarpment on Fee property (1983-88) on the east side of Quitchupah Canyon. The East

Three longwall panels were completed in 1987 as part of the project. The area of proposed escarpment subsidence (the "Experimental Mining Practice" area) is shown on Plate 5-1. The north ends of two of the longwall panels extended beyond the escarpment toward the canyon. The third longwall panel was located entirely beyond the cliff beneath the canyon wall.

To date, monitoring efforts associated with the experimental mining practice have established that subsidence has occurred in a predictable manner varying from one foot to seven feet with minimal surface disturbance. One of the independent sandstone blocks fell from the escarpment during subsidence and a few tension cracks were created along the cliff face. No other visible signs of mining were found even though the surface elevations have dropped several feet in some areas of the experiment. Monitoring stations have moved horizontally from a few tenths of a foot to nearly three feet. Post-mining monitoring of the surface above the longwall panels is continuing. A report which describes the experimental project and its results in greater detail has been prepared for submittal to the UDOGM.

Subsidence Monitoring. In 1976 (i.e., prior to the onset of subsidence), SUFCO Mine began collecting baseline topographic data from the lease~~permit~~ area using conventional survey methods.

The use of conventional survey methods for subsidence monitoring continued until 1985 (i.e., at the beginning of longwall mining), when the lease~~permit~~ area was flown to establish a set of baseline photography and a grid of surface elevations. Where possible, elevations were photogrammetrically determined from this baseline photography on an approximate 200-foot grid. These original horizontal and vertical data, together with the original conventional-survey data, serve as the comparative database for determining ground movement in subsequent years. A baseline was also established to monitor changes in vegetative cover with the use of color infrared aerial photography (CIR). The first baseline was done in 1987 for the existing leases. The baseline for the Quitchupah lease was flown in 1988 with CIR. The applicant will follow up with CIR coverage of the leases at least every five years. The CIR photographs are stored at the SUFCO Mine. CIR photography was taken in 1990, 1995, 1999, 2003 (East Fork Box Canyon only), and 2004. The next projected CIR flight dates will be in 2008, 2013, and 2018.

Additional aerial photography of the lease~~permit~~ area is currently obtained on an annual basis. New elevations are then determined at each of the previously-selected horizontal coordinates and the differences between the original and the new elevation measurements are used to generate a subsidence contour map. This map and supporting narrative are submitted annually to the UDOGM in the form of a subsidence report. This subsidence report outlines the history of subsidence at SUFCO Mine as well as the status of subsidence during the previous year.

Numerous control points have been established within the lease~~permit~~ area to assist in the subsidence surveys (see Plates 5-10A, ~~&~~ 5-10B & 5-10C). Current (2005) coordinates and elevations of these control points are provided in Table 5-2. Additional control points will be added as necessary when existing points become influenced by subsidence. Future points will typically consist of 3-foot lengths of No. 4 rebar embedded in concrete with a stamped brass cap for identification. Since geologic and mining uncertainties often force a change in planned mining sequences, future control points will be installed only after the mine panels are in their development phase.

All subsidence areas will be monitored and reported in the Annual Subsidence Report for a minimum of three years after no additional subsidence is detected within the area. The applicant will map and report areas 3 and 4 in the 1993 Subsidence Report as required by Division Order #93A issued May 11, 1993.

A annual monitoring program was developed to analyze the subsidence cracks related to undermining of the West Fork of Box Canyon. Mining in the area in 1999 did produce visible fracturing at the surface on both the northwest and southeast walls of the canyon in this area. The monitoring program includes measuring the offset and/or width of portions of selected subsidence cracks. Similar data will also be collected from specified segments of subsidence cracks that have occurred away from the walls of the canyon and do not appear to be influenced by the lack of bedrock support created by the canyon. Information gathered from this monitoring program, along with previous studies that SUFCO has performed, will be used to predict the effects of subsidence within other areas of the Pines Tract and other areas of the mine where similar geomorphologic and geologic conditions occur. This program was developed and implemented by the Fall of 2000. Subsidence cracks in the area of the West Fork of Box Canyon were surveyed for their location. However, in the years 2000 through 2003 the width and/or offset of the cracks were not measured or the records were not kept. Width and/or offset measurements were made in the Fall of 2004 and will again be made in the Fall of 2005 and every year thereafter. It is believed by the permittee that any change in the width of the cracks can easily be tracked on an annual basis rather than a semi-annual basis. The permittee has observed that most subsidence cracks that develop in the mining area do not change significantly after the first 4 to 6 months following their creation. The crack measurement records will be reported in the mines annual report. Subsidence cracks in the area of the West Fork of Box Canyon are located in Longwall area 10 that has been mined out since 2001, and the area is now assumed to be dormant. 2008 will be the last year these cracks will be monitored since there will not be anymore movement in this area.

Anticipated Effects of Subsidence. Future subsidence in the lease~~permit~~ area is anticipated to be similar to that which has occurred in the past. Subsidence is expected to average about 4 feet above longwall panels, with a draw angle of about 15 degrees. Tension cracks are expected to occur in areas of subsidence with these cracks healing to some degree following formation. Tension cracks are anticipated to be less pronounced above longwall workings than above continuous-miner workings.

Previous surveys have indicated that no substantial damage has occurred to vegetation as a result of subsidence within the lease~~permit~~ area. The only effects observed have been exposed plant roots where tension cracks have formed.

It is anticipated that subsiding under portions of East Fork Box Canyon and South Fork Quitchupah will result in a slight flattening of the stream gradient, which will increase pooling of the stream through a stretch of several hundred feet of the stream. Cracks will also likely develop across the East Fork Box Canyon Creek directly above the longwall panels and along the gate roads. These crack zones will form shortly after undermining of the stream bed. They are anticipated to be 1 to 2 inches or less in width with these cracks healing to some degree following formation. Details of

A discussion regarding the methods Sufco would employ to mitigate and replace an adversely affected State appropriated water supply is provided in Chapter 7, Section 7.3.1.8.

5.2.5.2 Subsidence Control

Adopted Control Measures. As indicated above, SUFCO Mine has adopted subsidence-control measures in areas where surface resources are to remain protected. These controls consist primarily of leaving support pillars in place in those areas designated on Plates 5-10A, ~~&~~ 5-10B & 5-10C as not planned for subsidence. Based on experience and data collected from the lease~~permit~~ area, the design of support pillars for those areas where subsidence is not planned has been based on the following equations:

$$SF = SD/OS \tag{5-1}$$

where SF = safety factor against pillar failure (fraction)

SD = support strength density (psi)
= $(Y_c)(1\text{-}ER)$

Y_c = average compressive yield strength of the coal (psi)
= 3090 psi for the Upper Hiawatha seam

ER = extraction ratio (fraction)
= $1-(A_p/A_t)$

A_p = pillar area (ft^2)

A_t = area supported by pillar (ft^2)

OS = overburden stress (psi)
= $(d)(D_o)/144$

d = overburden depth (ft)

D_o = overburden density (lb/ft^3)
= 160 lb/ft^3 for the lease~~permit~~ area

Based on these equations and data, the support pillar designs summarized in Table 5-3 have been derived. This equation does not take into account either size effect or shape effects and is based on a one-dimensional stress field. Historically this equation has provided good results when used in areas where a number of uniform pillars are extracted. One area (5 North panels) of the mine experienced pillar failure when the area was flooded with water after mining of the panels had been completed. This particular area was mined using a double pass technique and the mining height was from 14 to 18 feet. The resulting pillars varied from 25 feet x 25 feet to 40 feet x 40 feet. The underlying floor was a weak mudstone that lost its cohesive strength when wet. When the 1R5N and 2R5N panels were flooded the underlying mudstone became saturated and lost its cohesive strength. This allowed the pillars in the area with SF < 2.5 to fail, because frictional confinement on the bottom of the pillar was lost. To prevent reoccurrence the Applicant will commit to not flood areas of the mine that have small pillars and a weak mudstone floor in areas where subsidence is to be prevented.

Compliance With Control Plan. SUFCO Mine will comply with all provisions of the approved subsidence control plan.

Correction of Material Damage. SUFCO Mine will try to plan mining operations so that no material damage occurs as a result of subsidence in the lease~~permit~~ area. However, should material damage occur, SUFCO Mine will correct any material damage resulting from subsidence caused to surface lands to the extent technologically and economically feasible by restoring the land to a condition capable

The sedimentation-pond access road is maintained by SUFCO Mine as necessary to permit access to the pond during sediment removal. The truck loop road and the access road to the office and shop/warehouse complex are maintained by SUFCO Mine as necessary to provide a safe, smooth surface for vehicular traffic. The East Side road, Link Canyon Substation No. 2 access road and Link Canyon Portal access road are maintained as necessary within the disturbed area boundaries by SUFCO Mine to minimize erosion and allow occasional access to the substations. No sand or salt is applied within the disturbed area boundaries for snow and ice removal. The remaining roads in the lease~~permit~~ area are maintained by the U.S. Forest Service. SUFCO Mine has committed to repair damage to these public roads if this damage results from mining activities (e.g., subsidence).

5.2.8 Handling and Disposal of Coal, Excess Spoil, and Coal Mine Waste

5.2.8.1 Coal Handling and Transportation

Coal is removed from the underground workings using the mining methods and conveyor system described in Section 5.2.3. A material flow diagram for the surface at the mine portal is provided in Figure 5-1.

Run-of-mine coal is brought out of the mine by conveyor belt to a transfer bin. From the transfer bin, the coal is fed either to a temporary storage silo or to the crushing and screening system. After crushing and screening, the coal is loaded onto trucks (either through the truck loadout tube or by front-end loader) and transported. Lump, stoker, and crushed coal circuits exist in the system.

5.2.8.2 Overburden

No overburden is removed, handled, stored, or transported within the permit area.

5.2.8.3 Spoil, Coal Processing Waste, Non-Coal Waste, and Mine Development Waste

Excess Spoil. No spoil is generated at the SUFCO Mine.

Slope Stability. The stability of the mine access road embankment has been evaluated where the road enters the permit area. Results of this evaluation are presented in Appendix 5-8. This analysis indicates that the access road embankment has a minimum safety factor of 1.7 under static conditions. This value exceeds the safety factor of 1.3 required by R645-301-534.130.

An evaluation of the stability of the sedimentation-pond access road embankment is presented in Appendix 5-8. This evaluation indicates that the minimum static safety factor of the sedimentation-pond road embankment is 1.7. This value also exceeds the safety factor of 1.3 required by R645-301-534.130.

All other roads in the lease~~permit~~ area are owned and maintained by the U.S. Forest Service. No stability problems have been noted on these roads.

5.3.4.2 Environmental Protection and Safety

Safety and environmental protection were primary concerns during the design and reconstruction of the mine access road and construction of the sedimentation-pond access road. The grade, width, and surface materials used for the roads were selected to be appropriate for the planned duration and use of the roads.

5.3.4.3 Primary Roads

General. The only primary road (outside of the disturbed area boundary) used or maintained by SUFCO Mine is the mine access road. The extension of this primary road within the disturbed area boundary is know as the truck loop road. This road was designed and constructed in consultation with the U.S. Forest Service in a manner that provided protection to fish, wildlife, and related environmental values. The road is being maintained by SUFCO Mine to meet its design standards throughout the life of the mining and reclamation activities. Catastrophic events are repaired as soon as practical after the damage occurs.

The mine access road was designed and reconstructed and is used and maintained in a manner that prevents damage to public or private property. Only nonacid- and nontoxic-forming materials were

Final surface configuration maps and cross sections for the East Spring Canyon site are provided on Plates 5-3A&B and 5-4, respectively. The primary access road to the mine yard will be removed at the permit boundary. Existing public access roads within the lease~~permit~~ area will remain following reclamation. No facilities related to the coal mining operations will remain in the permit area following reclamation. Information regarding the final surface configuration of the waste-rock disposal site is provided in Volume 3. Final surface configuration maps and cross sections for the 4E Fan facility, Link Canyon Substation facility and all out-by mine portals are provided on Plates 5-2C, 5-2D, 5-2E and 5-2F, respectively.

5.4.2.4 Removal of Temporary Structures

All surface structures associated with the mining operation will be removed as outlined in Section 5.4.2.2. A description ensuring that all structures and sedimentation ponds have been removed will be provided to the UDOGM before seeking bond release or abandoning the permit area.

5.4.2.5 Removal of Sedimentation Ponds

Information regarding removal of primary sedimentation ponds and overflow pond associated with the SUFCO Mine is provided in Section 5.4.2.2 for the East Spring Canyon facility and in Volume 3 of this M&RP for the waste rock disposal site. The timetable for removal of the minesite ponds is indicted in Figure 5-2.

5.4.2.6 Roads

The primary mine access road will be reclaimed beginning at the guard shack at the entry to the mine yard. This road will be regraded by removing any remaining asphalt, removing fill from beneath the road to the natural ground surface, and placing the fill against the adjacent cut slope. Placement and compaction of the backfill material will be as indicated in Section 5.2.4.2.

Proposed reclamation contours following closure of the mine access road are presented in Plate 5-3A&B. The roadside culvert referred to as Pipe No. 5 (see Chapter 7) that exists immediately south of the guard shack will be retained for runoff control along the unreclaimed portion of the road.

CHAPTER 6

GEOLOGY

The Applicant has a Resource Recovery and Protection Plan (R2P2) on file with the Bureau of Land Management. This R2P2 contains a detailed description of the two mineable coal seams on the SUFCO Mine leasehold. The overlying Duncan Seam is not considered mineable (see Section 5.2.2).

There is a plugged and abandoned gas well located in Section 23, T21S, R5E in the Pines Tract. No other oil or gas wells are known to exist within a quarter mile of the mine area. No other water wells have been drilled in the ~~permit~~lease area except those drilled by the applicant for the purpose of monitoring the groundwater.

6.2.3 Geologic Determinations

The information required by UDOGM to make a determination of the acid or toxic forming characteristics of the site strata is presented in Section 6.2.4.3 of this M&RP.

The information required by UDOGM to make a determination as to whether the reclamation plan, described in Section 5.40, can be accomplished is presented in Section 6.2.4.

The information required to prepare the subsidence control program is addressed in Section 6.2.4.

6.2.4 Geologic Information

6.2.4.1 Regional Setting

The SUFCO Mine is located beneath the Old Woman Plateau, 20 miles east of Salina, Utah. The Old Woman Plateau lies in the Wasatch Plateau Subprovince of the Colorado Plateau Physiographic Province.

Stratigraphy. All rock units within the SUFCO Mine property boundaries are sedimentary (Plate 6-1 and Figure 6-1). No igneous or metamorphic units are found in the area. Most exposed, consolidated sedimentary rocks in the area were deposited during the Cretaceous Age of the Mesozoic Era. The uppermost North Horn Formation is Upper Cretaceous to lower Tertiary (Paleocene) in age. The oldest unit is the Upper Cretaceous Masuk Member of the Mancos Shale, Castlegate Sandstone

The Castlegate Sandstone extends across the eastern part of Utah, along part of the Bookcliffs and the entire length of the Wasatch Plateau (Spieker, 1931) but loses its character as a cliff-former south of Interstate Highway 70. It is correlative to the Cliffhouse Sandstone of southwestern Colorado and northern New Mexico (McGookey, 1973). In the Wasatch Plateau, its thickness varies from 50 to 500 feet (Spieker, 1931). It is thickest in Price River Canyon at the north end of the Wasatch Plateau. The Castlegate Sandstone is exposed along the rims of Convulsion and North Fork of Quitchupah Canyons. Its thickness varies across the SUFCO Mine property from about 120 to 260 feet with a general northwestward thickening.

The Castlegate Sandstone is a fluvial deposit composed mostly of sandstone, conglomeratic sandstone, pebble conglomerate, and gritstone lenses. There are some thin interbeds of siltstone and claystone, especially toward the base of the unit. The member forms much of the surface of Old Woman Plateau in the southern part of the mine property, and creates a nearly unbroken cliff along the canyons which flank the SUFCO Mine on the south and east.

Price River Formation

The Price River Formation is the uppermost member of the Mesa Verde Group and in the vicinity of the mine it caps the mesa which forms the Old Woman Plateau. The formation is reported to be approximately 550 feet thick in the mine area.

The Price River Formation consists of gray to white gritty sandstone, interbedded with subordinate shale and conglomerate. The formation is resistant to weathering and is a ledge and slope former due to interbedding of resistant sandstones with less resistant shales and claystones.

North Horn Formation

The North Horn Formation straddles the Cretaceous-Tertiary boundary. The maximum thickness of the North Horn within the ~~permit~~lease area occurs on Big Ridge where it is estimated to be approximately 430 feet thick. A few seasonal springs are found in the North Horn. The Castlegate reappear in the bedrock again outside of the joint as the en echelon pattern continues. In the Pines Tract and Quitchupah areas, jointing generally does not appear to have significant effect on the location or propagation of subsidence related fractures. Exceptions to this occur where the Castlegate Sandstone has been subsided at or near the rim of steep drainages or canyons. In these areas, large blocks of sandstone have been observed to rotate toward the drainage during subsidence. Often, after subsidence is complete, the blocks remain at their new attitudes leaving an opening between the block and the in-place sandstone. Where the aperture is deemed hazardous, Sufco has backfilled the openings.

Subsidence in the Muddy tract area will occur in the Price River and North Horn Formations. Because these formations consist of ledge/slope forming interbedded sandstone, siltstone, shale and limestone and are typically overlain by a mantle of soil, little bedrock is exposed at the surface. Therefore, it would be difficult to determine the relationship of subsidence crack formation and bedrock jointing. It would be appropriate to assume, however, that subsidence cracks will form in this tract similarly to those found in the previously mined and subsided areas of the Sufco mine.

6.3.3 Exploration Drilling

The purpose of exploration drilling is to obtain stratigraphic and coal quality information to make for more accurate mine planning and maintain a high level of miner safety. The exploration area is located within the current mining lease~~permit~~ boundary of Permit ~~ACT~~/041/002 as shown on Plate 6-1. The SUFCO Mine is planning to drill ~~up to 5drill~~ approximately 10 drill holes over the next 5 years. In the case of the SITLA lease, drilling will be conducted as approved under a Division-approved Minor Coal Exploration Permit. As in the past, drilling on federal leases with USFS administered surface will continue to be permitted through the BLM Exploration Plan process. The SUFCO Mine understands that UDOGM, the BLM, and the USFS all have a important roles in approval of drilling and will continue to work diligently to ensure requirements of all involved agencies are met prior to conducting surface exploration work.

Drill site preparation, drilling, and final reclamation work will last approximately two weeks per year. Reclamation will be concurrent with drilling to minimize the duration of the project.

The type of exploration to be used is rotary drilling or continuous wireline core drilling using a 2,000 ft rated drill rig. The drilling procedure for rotary drilling will be as follows: rotary drill using a tri-cone bit to core point, core the coal intervals using air with a diamond or carbide bit, ream the cored interval and rotary drill to total depth. Air will be used as a drilling medium as much as possible though conditions may warrant water, foam or mud. The drilling procedure for continuous wireline core drilling will be as follows: continuous core drill through total depth. Drilling medium will be water, polymer, and/or mud. Upon completion of drilling, the holes will be geophysically logged then plugged the full depth with concrete or a combination of concrete and bentonite hole plug or abandonite as approved by the BLM. A total of up to 4.0 acre-feet of water will be pumped from the North and/or South Fork of Quitchupah Creek, ~~or~~ Muddy Creek , or the Sufco minesite for use during drilling and hole plugging operations. No coal will be removed beyond that which is cored.

Some of the drill sites will be accessed using existing wheel tracks or over the existing surface and a few will require that new roads be built off of U. S. Forest Service roads or existing wheel tracks ~~(see amended Plate 6-1)~~. Helicopter-supported drilling techniques ~~may~~will also be utilized at times to minimize surface impacts.

The drill sites will be approximately 80 feet by 100 feet in size. One half of the site will be for the drill rig and water truck while the other half will have 1 to 2 mud pits and temporary supply storage.

The applicant requests that any information from exploration drilling be kept confidential and that public access to any of the information be limited to only persons with an interest which is or may be adversely affected as provided under Section 40-10-10 (4) of the Act.

Mine Yard Directional Horizontal Burn Drilling

One horizontal directional exploration drillhole will be drilled from within the permitted Sufco minesite at a location shown on Figure 6-2. This drillhole will be drilled to determine coal burn location west of the Sufco minesite for mine planning purposes. The directional drillhole will be nominally 3.8 inch and will be drilled almost entirely within the Upper Hiawatha coal seam. Only minor excavation of existing mine yard fill material will occur on the existing permitted Sufco minesite. A small ditch and mudpit/sump will be constructed to contain drill water and fluids. Drill

CHAPTER 7

HYDROLOGY

LIST OF APPENDICES (Continued)
(Appendices appear in Volumes 7 and 8)

7.20 Environmental Description

7.2.1 General Requirements

This section presents a description of the premining hydrologic resources within the permit area and adjacent areas that may be affected or impacted by the proposed coal mining and reclamation operation.

7.2.2 Cross Sections and Maps

7.2.2.1 Location and Extent of Subsurface Water

Groundwater occurs in perched zones of limited areal extent within the ~~permit~~lease area. The PHC studies conducted by Mayo and Associates (Appendix 7-17 and Appendix 7-18) have determined that none of the formations down through the Blackhawk support a continuous aquifer. According to Mayo's research all of the aquifers within the permit area and adjacent areas are perched and discontinuous so it is not possible to represent a potentiometric surface for the area.

Seasonal variations in well water levels are discussed in Section 7.2.4.1.

7.2.2.2 Location of Surface Water Bodies

A map showing the location of surface water bodies (such as streams, ponds, and springs) for which water rights exist or for which there are pending water rights applications is provided as Plate 7-2. A listing of water rights data (names, locations and ownership) is presented in Appendix 7-1. Other than for the indicated springs, no water rights exist for groundwater in the permit and adjacent areas.

7.2.2.3 Locations of Monitoring Stations

Surface water and groundwater monitoring stations associated with the SUFCO operation are located as shown on Plate 7-3. Approximate surface elevations of the monitoring stations are also indicated on Plate 7-3.

7.2.2.4 Location and Depth of Water Wells

No water-supply wells exist in the permit or adjacent areas. Groundwater monitoring wells in the area are located as shown on Plate 7-3. Depths of these wells and other completion details are summarized in Table 7-1.

7.2.2.5 Surface Topography

Surface topographic features in the permit and adjacent areas are shown on the base maps used for Plate 7-3.

7.2.3 Sampling and Analysis

All water samples collected for use in this M&RP have been analyzed according to methods in either the "Standard Methods for the Examination of Water and Wastewater" or 40 CFR parts 136 and 434. Where feasible, these same references have been used as the basis for sample collection.

7.2.4 Baseline Information

Surface water, groundwater, and climatic resource information is presented in this section to assist in determining the baseline hydrologic conditions which exist in the area of the mine. This information provides a basis to determine if mining operations have had, or can be expected to have, a significant impact on the hydrologic balance of the area.

7.2.4.1 Groundwater Information

This section presents a discussion of baseline groundwater conditions in the mine area. A discussion of the groundwater conditions in the SUFCO ~~permit~~lease area is presented in this section and appended by Appendix 7-17. A discussion of groundwater conditions in the Pines Tract is presented in Appendix 7-18 of this Chapter. A discussion of groundwater conditions in the West Coal Lease Modifications is presented in Appendix 7-24 of this Chapter. A discussion of groundwater conditions at the waste rock disposal site is provided in Volume 3 of this M&RP.

The locations of wells and springs in the mine area are presented on Plate 7-3. The wells in the mine area are all water monitoring wells, not water supply wells. Water rights for the mine and adjacent areas are addressed in Section 7.2.2.2 of this M&RP. With the exception of the potable use of source 94-87 by SUFCO, all other groundwater use (seeps and springs) is confined to stock watering.

AQUIFERS

Geologic conditions in the permit and adjacent areas are described in detail in Chapter 6 of this M&RP. Groundwater occurrences within the permit and adjacent areas occurs predominantly in the Blackhawk Formation and Star Point Sandstone. However, perched aquifers of limited areal extent are present in the geologic formations. Hydrogeologic conditions within the permit and adjacent areas are summarized below.

North Horn Formation. The North Horn Formation crops out in the northwest portion of the ~~permit~~lease area. This formation consists of interbedded shale, sandstone, and limestone. Data presented in Appendix 7-2 indicate that only one seep and one spring issue from the North Horn Formation within the ~~permit~~lease area. Recharge occurs to outcrops of the North Horn Formation west of the ~~permit~~lease area (Thiros and Cordy, 1991). Thus, it may serve as an aquifer in some portions of the western adjacent area.

Upper Price River Formation. The upper Price River Formation consists of about 450 feet of interbedded sandstone and claystone. Within the ~~permit~~lease area, the upper Price River Formation has not been identified as a significant aquifer. Thiros and Cordy (1991) estimated that combined recharge to the upper Price River Formation and the Castlegate Sandstone is limited to 1.2 percent of the total annual precipitation. As indicated in Appendix 7-2, a few isolated springs have been identified discharging from the sandstone lenses within the formation. No groundwater has been identified within this formation during the exploration drilling which has been conducted from the top of the plateau. As a result no monitoring or water supply wells have been completed in this formation within the mining area.

Five monitoring wells have been completed in a massive sandstone unit in the Price River Formation at the waste rock disposal site. Hydrographs of three representative wells (B-3, B-6, and B-8) are depicted in Figure 7-1. Seasonal fluctuations are typically less than one foot in wells B-3 and B-6, and less than three feet in B-8. All three wells display a general downward trend in water levels from spring to late summer (see also Appendix 7-4 and Volume 3).

Castlegate Sandstone. The Castlegate Sandstone consists of an estimated 120 to 260 feet of medium to coarse-grained sandstone with a few thin interbedded mudstones or shales near the base. The sandstone is conglomeratic, forms prominent cliffs along the outcrop, and is well cemented with calcarious cement.

A limited number of springs issue from the Castlegate Sandstone in the Quitchupah lease area, with flow generally less than 1 gpm. In the Pines Tract area, several springs issue from and near the base of the Castlegate Sandstone. The waters from these springs feed the Main Fork and East Fork of Box Canyon Creek. Base flow from these springs is generally less than 1 to 2 gpm with a few flowing at rates of 5 to 6 gpm.

Based on information from the exploration drill holes and observation wells in the ~~permit~~lease area, the Castlegate Sandstone contains small quantities of groundwater. No significant quantities of groundwater (more than 2 gpm) were encountered in any of the exploration holes nor was groundwater identified in all drill holes.

Of the observation wells completed in the Castlegate Sandstone in the ~~permit~~lease area, two (US-77-9 and 89-16-1W) have been dry during their entire period of record. Two additional wells (US-77-8 and 89-20-2W) have only a brief period of record (due to lack of water or time since installation, respectively). Hydrographs of the remaining two Castlegate Sandstone observation wells (US-80-2 and US-80-4) are presented in Figure 7-2. Water-level data for all wells are provided in Appendix 7-3. Seasonal fluctuations of groundwater levels in these wells have typically been less than one foot.

Coal exploration holes drilled in and near the Pines Tract by the USGS, have geophysical logs indicating similar conditions for the Castlegate Sandstone. Exploration Hole W-TP-4-EW found fluids present at a depth of 82 feet below ground surface, within the Castlegate Sandstone. Exploration holes W-TP-3-EW and W-TP-2-EW did not encounter fluids within the Castlegate Sandstone.

This formation is not considered to be a significant regional aquifer. It is assumed that the groundwater occurrence within the Castlegate Sandstone is limited to isolated perched zones contained in the more permeable sandstone lenses or within weathered bedrock and fractures/joints at and near the escarpments within Box Canyon. Because groundwater occurrence within the Castlegate Sandstone is not continuous over the permit and adjacent areas, no potentiometric surface could be developed for the unit.

Star Point Sandstone. The Star Point Sandstone is fine to medium grained in texture with the coarser grained material occurring in the upper portions of the formation. The Star Point forms a well defined cliff between the slopes of the Mancos Shale and the overlying Blackhawk Formation. Except where eroded or exposed in deep canyons, the Star Point Sandstone underlies the entire ~~permit~~lease area.

In 1989, four monitoring wells were completed in the basal Blackhawk/upper Star Point Formation. The wells ranged from 1012 to 1300 feet deep and were completed in the intervals indicated on Table 7-1. These holes did not encounter significant quantities of groundwater.

Recharge to the Star Point Sandstone probably occurs primarily from vertical movement of the water through the overlying Blackhawk Formation. Discharge from the Star Point is considered to be primarily to adjacent canyons at the contact with the underlying Mancos Shale. These discharge points are generally covered with alluvial fill of the stream systems. Therefore, little surface expression of the discharge has been identified.

Mancos Shale. Underlying the entire mine ~~permit~~lease area and exposed in the deep canyons is the Mancos Shale. This dark, slope-forming, marine shale is relatively impermeable and is not considered to be a regional or local aquifer (Danielson and Sylla, 1983).

Quaternary Alluvium. Unconsolidated Quaternary deposits are present along streams and generally consist of silts, sands, and occasional gravels. The deposits, which have low to moderate permeability, receive water from the adjacent bedrock in some of the deeply incised canyons. Discharge from these materials is to the surface water system. SUFCO collects water in the alluvium at the base of East Spring Canyon and pumps it to the mine for use as culinary water. The average flow from this source is approximately 25 gpm. Water is probably supplied to the alluvium by seepage from the Blackhawk Formation and Star Point Sandstone.

RECHARGE

Recharge within the ~~permit~~lease area occurs primarily on the exposed upland outcrops of the Price River Formation and the Castlegate Sandstone. The annual recharge to these units is estimated to be 1.2 percent of the total annual precipitation. "Much recharge occurs" on outcrops of the Flagstaff Limestone and the North Horn Formation west of the ~~permit~~lease area (Thiros and Cordy, 1991). Recharge to the Blackhawk Formation and the Star Point Sandstone probably occurs primarily from vertical movement of water through the overlying formations. The Mancos Formation underlies the entire area and is exposed in the deep canyons. It is relatively impermeable. Groundwater descending from the Star Point Sandstone flows along the Mancos-Star Point contact and discharges to the surface.

Locally, recharge is probably greater where surface fractures intersect topographic highs (plateaus). These areas occur where the North Horn Formation or the Castlegate Sandstone crops out (Thiros and Cordy, 1991). The North Horn Formation crops out in the northwest corner and along the western border of the ~~permit~~lease area. The Castlegate Sandstone generally crops out along the top edges of the steep-walled canyons (Plate 6-1). However, in the east and north central parts of the permit area, the Castlegate Sandstone caps the plateaus in relatively large areas. According to Thiros and Cordy (1991), recharge is increased where fractures extend down through the Price River Formation to the Castlegate Sandstone. This may occur in the southwestern corner of the permit area where subsidence cracks have been seen to penetrate the Castlegate Sandstone and Price River Formation (Thiros and Cordy, 1991). Additionally, faults along the western and northern margins of the permit area may increase secondary permeability, thus locally increasing recharge.

Recharge occurs in the northwest corner (T.21 S., R.4 E., sections 11 and 23) and the northeastern part of the permit area (T.21 S., R.5 E., section 16). The first area is a topographic high and fractured where the North Horn Formation crops out. The second area is a topographic high, capped by the Price River Formation. Linear features that imply fracturing are located in this area (Plate 6-1 and SUFCO, 1992).

Recharge to shallowly circulating groundwater systems within the Castlegate Sandstone and Blackhawk Formation also occurs in the Pines Tract area. These shallow groundwater systems appear to occur within approximately 1000 feet of the Box Canyon escarpments.

The recharge age for water flowing into the SUFCO mine was estimated at 70 years or older (Thiros and Cordy, 1991). Mayo and Associates (1997a and 1997b) identified mean groundwater residence times for in-mine discharges of 7,000 to 20,000 years. This indicates that recharge to the Blackhawk aquifer is not being affected by the increased hydraulic conductivities created by subsidence.

Assuming mass-balance and stable hydrologic conditions in the permit area, over the long term, recharge must be equal to discharge. Recharge occurs mostly on the plateaus and over time moves found in groundwater samples only for sulfate and TDS concentrations (with recommended standards of 250 mg/l and 500 mg/l, respectively). All of the sulfate exceedances and most of the TDS exceedances occurred in groundwater collected from monitoring wells at the waste-rock disposal site. These exceedances are probably due to the natural dissolution of marine salts known to exist in the local strata (Waddell et al., 1981).

7.2.4.2 Surface Water Information

WATER QUANTITY

Major surface drainages in the permit and adjacent areas are depicted in Figure 7-4. As indicated, the ~~permit~~lease area exists entirely within the Muddy Creek watershed. Most of the ~~permit~~lease area drains southward into Quitchupah Creek via the North Fork of Quitchupah Creek and various ephemeral tributaries. Quitchupah Creek flows southeastward into Ivie Creek which in turn flows eastward into Muddy Creek. The northeast portion of the ~~permit~~lease area, including the majority of the Pines Tract, drains into Muddy Creek via Box Canyon.

Based on flow data obtained during the collection of water-quality samples, the following streams are considered perennial within the ~~permit~~lease area:

- North Fork of Quitchupah Creek (as measured at stations SUFCO-007 and SUFCO-042)
- South Fork of the North Fork of Quitchupah Creek (as measured at station SUFCO-006)
- Quitchupah Creek (as measured at stations SUFCO-041 and SUFCO-046)

and 002 (located near the base of the fourth stream segment), surface water has not been observed in the channel.

Station locations are indicated on Plate 7-3. All other streams within the permit and adjacent areas are ephemeral.

Based on channel-geometry measurements and a technique described by Fields (1975), Waddell et al. (1981) estimated that the historic average annual flow of Quitchupah Creek is approximately 3800 acre-feet immediately above the confluence with Link Canyon. With a drainage area of 85.4 square miles (Waddell et al., 1981), this results in a unit-area average annual streamflow of 44.5 acre-feet per square mile per year (AF/mi^2/yr) for Quitchupah Creek above Link Canyon.

The U.S. Geological Survey collected streamflow data from Ivie Creek from 1951 through 1961 at a station located approximately 11 miles south of the mine surface facilities. During the period of record, data published by the U.S. Geological Survey indicate that the average annual streamflow at this station was 2830 AF/yr. Based on a published drainage area of 50 mi^2, the unit-area average annual streamflow of upper Ivie Creek was 56.6 AF/mi^2/yr. This compares favorably with the unit-area yield of Quitchupah Creek and with the mean annual water yields presented by the Utah Division of Water Resources (1977).

Seasonal variations in historic streamflow in the vicinity of the ~~permit~~lease area are portrayed graphically in Figure 7-5. The Muddy Creek station is located approximately 6 miles downstream from the confluence of Box Canyon and Muddy Creek while the Ivie Creek station was located about 11 miles south of the mine surface facilities. These trends (which are considered representative of perennial streams in the permit and adjacent areas) indicate that peak monthly stream flows in the area generally occur in May or June, probably as a result of snowmelt runoff. The Ivie Creek data also indicate that an additional rise in the monthly hydrograph occurs in July or August, probably as a result of summer thunderstorm activity.

These potential impacts are addressed in the following sections of this M&RP.

7.2.8.2 Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter 6 of this M&RP. Baseline hydrologic information is presented in Sections 7.2.4.1 and 7.2.4.2 of this M&RP. The baseline monitoring sources are believed to be representative of existing ground water and surface water. An additional inventory is not planned unless circumstances dictate a need for change.

7.2.8.3 PHC Determination

Potential Impacts to the Hydrologic Balance. Potential impacts to the hydrologic balance are addressed in the following subsections of this M&RP and in Appendices 7-17, 7-18, 7-19, ~~and~~ 7- 20 and 7-24. Appendices 7-18, ~~and~~ 7-20 and 7-24 contain PHC determinations for mining activities in the Pines Tract, ~~and~~ SITLA Muddy Tracts and West Coal Lease Modifications, respectively.

Acid- or Toxic- Forming Materials. Information on acid-and toxic-forming materials is presented in Chapter 6. These data reveal boron, sodium absorption ratio, and specific conductance exceedances of the Table 2 guidelines for management of topsoil and overburden (Leatherwood and Duce, 1988) in waste rock from the SUFCO mine. As noted in Section 7.2.4.2 of this M&RP, the alkalinity of the mine discharge water typically exceeds the acidity of this water by a factor of 20. Additionally, mine discharge water typically meets the standards for water quality for the state of Utah (Utah Water Quality Board, 1987). Thus, analytical data obtained from mine-water discharges indicate that although potential exists in localized portions of the mine for acid- or toxic-forming materials to be present, there has been no known impact to the surface or groundwater in the permit and adjacent areas.

Sediment Yield. The potential impact of mining and reclamation on sediment yield is an increase in sediment in the surface waters downstream from disturbed areas. Sediment-control measures (such as sedimentation ponds, diversions, etc.) have been installed to minimize this impact. These facilities are regularly inspected (see Section 5.1.4) and maintained.

ephemeral streamflow, these subsidence-caused diversions would be small in volume. When a fracture becomes sealed with bentonitic materials available in the ~~permit~~lease area (Thiros and Cordy, 1991), the diversion either ceases or flows into a higher stratigraphic unit. Thus, potential impacts would be minor and not of significant concern.

The impact of the TDS and sulfate concentration increases on surface-water resources in the permit and adjacent areas is considered minimal for three reasons. First, surface water in the permit and adjacent areas has been classified in the Utah Department of Environmental Quality Wastewater Disposal Regulations as Class 3a and 4 water (protected for cold water aquatic life and agricultural uses, respectively). No sulfate discharge standard exists for either of these two classifications. The only TDS standard is for Class 4 water, with a discharge limitation of 1200 mg/l. Thus, the mine water does not exceed the applicable discharge standard and small amounts of surface water diverted through the groundwater system would not cause exceedances of the applicable standards.

Second, according to data presented in Section 7.2.4.2, although the discharge of mine water into the North Fork of Quitchupah Creek increases the TDS and sulfate concentrations of the receiving water (compare data from SUFCO-006, SUFCO-007 and SUFCO-042), the TDS concentration of the discharge water is less than that of Quitchupah Creek above the influence of the mining operation (compare data from SUFCO-046). As a result of these factors, the impacts of increased TDS and sulfate concentrations in the mine-water discharge relative to the adjacent natural water are not considered significant.

Finally, as indicated on Plate 6-1, surface water in the North Fork of Quitchupah Creek flows across Mancos Shale immediately downstream from the mine discharge point. Similarly, Quitchupah Creek crosses Mancos Shale immediately downstream from the confluence with East Spring Canyon. Since the Mancos Shale is a gypsiferous formation, sulfate and TDS concentrations are naturally high in areas underlain by this unit. Thus, the additional input of these constituents from the mine waters to local streams is considered minimal.

As indicated previously, tension cracks created by subsidence may locally increase the rate of downward percolation of groundwater. However, as indicated by Mayo in Appendix 7-17, the of being intercepted by subsidence fractures that extend to the land surface. In addition, the broad depressions created by subsidence may locally retain runoff that would normally discharge from an area. Although surface cracks that result from subsidence in the ~~permit~~lease area tend to heal with time (see Appendix 5-4), stream flows may be partially intercepted prior to completion of the healing process. However, the following factors indicate that the impact of subsidence on streamflow will be minimal:

1. Bentonitic shale and plastic flow in mudstone within perching layers could possibly slow or stop the downward movement of previously perched groundwater (Thiros and Cordy, 1991).

2. Field observations indicate that there are no sustained above normal inflows in the mine. Thus, flow along fractures is either from a relatively small source, or the conduits become sealed quickly.

3. Ephemeral streamflow in the area is sporadic, allowing significant periods of time which may allow for surface cracks to heal between flow events.

4. Ephemeral streamflow typically carries a high sediment load. During precipitation runoff events, perennial streams will also carry a high sediment load. This sediment will fill remaining cracks. As the cracks heal, the potential for interception of streamflow is minimized.

5. The depressions created by subsidence are sufficiently broad that changes in slope are not typically of an ample magnitude to cause ponding in anything other than local areas. If ponding does occur, the shallow depressions will fill with sediment quickly due to the periodic high sediment load of streams and the drainage will return to the previous pattern.

Groundwater and Surface Water Availability. The potential impacts of mining on reductions in surface-water availability are discussed above. As indicated, these impacts are not considered to be significant.

As noted in Section 7.2.4.2, groundwater is encountered in the SUFCO mine and pumped to the surface, generally into the North Fork of Quitchupah Creek at UPDES station 003.

According to Mayo (Appendix 7-17), the rate of discharge from the mine has increased since 1987 from approximately 1.0 cfs (450 gpm) to about 3.56 cfs (1,600 gpm).

It should be noted that the discharge of mine water to a stream probably results only in a local increase in flow and not a basin-wide increase. As noted on Plate 6-1, the Mancos Shale outcrops in the North Fork of Quitchupah Creek just upstream from the mine-water discharge point and in Quitchupah Creek above the confluence with East Spring Canyon. The shales of this formation have a low permeability (Waddell et al., 1981), thus forcing groundwater to the surface as streamflow. Thus, although the discharge of water from the mine may result in a local loss of groundwater and gain in surface water, this discharge does not disrupt the hydrologic balance of the basin.

The long-term mean mine discharge to North Fork Quitchupah Creek is 980 gpm and discharge varies between 460 and 1760 gpm. The mean upstream flow during high-flow conditions (June) is 2,650 gpm and during low-flow conditions (October) the flow is 290 gpm. Thus, mine discharge represents a mean increase in creek discharge of 37% and 337% for June and October, respectively. The mean low flow discharge measured at site 042, 5 miles downstream from the mine discharge point, is 950 gpm. This suggests that the lower reaches of North Fork Quitchupah Creek could go dry in late summer and early fall without the contribution of mine water to the stream.

Subsidence has occurred in the ~~permit~~lease area (Plate 5-10). More subsidence is expected to occur in the future as longwall mining progresses. Fractures that remain open or fill with permeable material would locally increase the hydraulic conductivity of the strata. However, when tension fractures intercept mudstones or shale units that contain bentonitic or montmorillonite clays, these fractures become sealed, stopping vertical flow (Thiros and Cordy, 1991). When tension fractures intercept strata that are more brittle or less amenable to sealing by clays, such as the Castlegate Sandstone, these fractures will heal naturally by filling in with silt and organic material such as sticks, pine needles, pine cones, and pine cone fragments. This natural healing could take longer to seal the cracks with the potential to impact water resources for a period of time. A discussion of the potential impacts to water resources due to subsidence is provided in Section 7.2.8.3 of this M&RP and in Appendix 7-17. DeGraff (Appendix 5-4) indicates that tension cracks in the ~~permit~~lease area typically heal quickly. There are no sustained above normal inflows in the mine due to mining or subsidence. Thus, most fractures in the ~~permit~~lease area appear to become sealed in a relatively short period of time. Intersection

The only actual loss of groundwater from the hydrologic balance is that water which is the difference between the average as-shipped moisture minus the inherent moisture or in-situ moisture of the coal and leaves the basin upon mining. Based on an average coal moisture loss of groundwater content of 1.8 percent and a long-term coal production rate of 6 million tons per year, approximately 80 AF/yr of groundwater is removed from the basin. This represents about 2 percent of the average annual flow of Quitchupah Creek above Link Canyon.

Several springs and stream locations in the ~~permit~~lease area are monitored for quantity and quality as prescribed by the M&RP water monitoring program. Analysis of the monitored flows indicated that very little impact has occurred to springs and streams. Erik Petersen of Petersen Hydrologic, Inc evaluated the flow data collected from several springs and surface flows in the Box Canyon drainage. His evaluation was forwarded to Sufco in the form of a letter report dated August 14, 2003 and is included in Appendix 7-19. Mr. Petersen determined that since mining began in the Pines Tract, a few the area springs have exhibited an increase in flow during a period of prolonged drought. He also concluded that perhaps one spring, Pines 303, in the lower portion of the Box Canyon, may have experienced reduced flows as a result of mining activities. However, because of the prolonged drought in the area that began in 1998, it is not possible to determine with certainty whether mining activities, drought conditions, or both have resulted in the loss of spring flow. A loss in flow from this spring was a predicted possibility described in the Pines Tract EIS. The loss of flow from this spring(less than 4 gpm) has apparently not adversely affected area vegetation or wildlife. Because of the increased discharge of springs farther up canyon, the loss of the less than the 4 gpm contribution of ground water from Pines 303 to Box Canyon Creek is insignificant to the total flow of the creek. No water rights were found to have been filed on this spring discharge.

Mr. Petersen has noted an increase in the flow of springs Pines 209 and 212 and in the flow of the Main Fork of Box Canyon Creek that appears to coincide with mining in the western portion of the Pines Tract. He reasons that the increase in spring flow is related to subsidence enhanced recharge or hydraulic conductivity of the aquifers sourcing the springs. The increase in spring flow has resulted in the increase in flow in the Main Fork of Box Canyon Creek. This has been noted as a positive impact to the creek during a time of drought. Analysis of the flow data presented by Petersen suggests the increase in flow from these springs may be short lived. He has also indicated that flow from these springs will not cease but should return to near pre-mining rates. In fact, the data presented in his August 14, 2003 letter report suggests the flow rates may already be beginning to return to pre-mining rates.

Potential Hydrocarbon Contamination. Diesel fuel, oils, greases, and other hydrocarbon products are stored and used at the site for a variety of purposes. Diesel and oil stored in above-ground tanks at the mine surface facilities may spill onto the ground during filling of the storage tank, leakage of the storage tank, or filling of the vehicle tank. Similarly, greases and other oils may be spilled during use in surface and underground operations.

The probable future extent of the contamination caused by diesel and oil spillage is expected to be small for three reasons. First, because the tanks are located above ground, leakage from the tanks can be readily detected and repaired. Second, spillage during filling of the storage or vehicle tanks is minimized to avoid loss of an economically valuable product. Finally, the Spill Prevention Control and Countermeasure Plan presented in Appendix 7-6 provides inspection, training, and operation measures to minimize the extent of contamination resulting from the use of hydrocarbons at the site.

The potential for hydrocarbon contamination of the environment at the Link Canyon Substation or the reopened Link Canyon Mine Portal is minimal since no fuels or lubricants will be stored at this site. If a catastrophic failure of the transformers at the substation occurred, the minimal volume of oil would be contained behind the berm to be built around the equipment.

Periodically due to difficult recovery conditions or roof collapse, mining equipment is abandoned underground. Abandoned mining equipment locations are shown on Figure 7-7. Prior to leaving equipment underground, lubricating and hydraulic fluids are removed to the extent possible. Since the equipment is steel and not too different compositionally from the roof support throughout the mine, contamination to ground water from abandoned equipment will cause minimal, if any, disturbance to the hydrologic balance within the permit and adjacent areas and is not expected to cause material damage outside the ~~permit~~lease area. Assuming the mine were to flood and the abandoned equipment were to be covered with water, several probable results and impacts can be evaluated:

1. Flooding of the abandoned mine might be relatively rapid, but once flooded, flow of ground water into, through, and out-of the void spaces of the mine should be slow.

7.30 Operation Plan

7.3.1 General Requirements

This permit application includes an operation plan which addresses the following:

- Groundwater and Surface Water Protection and Monitoring Plan;
- Sediment Pond Sludge Sampling and De-watering Plan;
- Design Criteria and Plans;
- Performance Standards; and
- Reclamation Plan.

7.3.1.1 Hydrologic-Balance Protection

Groundwater Protection. To protect the hydrologic balance, coal mining and reclamation operations will be conducted to handle earth materials and runoff in a manner that minimizes acidic, toxic, or other harmful infiltration to the groundwater system. Additionally, SUFCO will manage excavations and disturbances to prevent or control discharges of pollutants to the groundwater. SUFCO commits to replace loss of any surface water identified for protection in this M&RP that are impacted by mining at the SUFCO mine.

Surface Water Protection. To protect the hydrologic balance, coal mining and reclamation operations will be conducted to handle earth materials and runoff in a manner that minimizes acidic or toxic drainage, prevents, to the extent possible, additional contributions of suspended solids to streamflow outside the permit area, and otherwise prevents water pollution. Additionally, SUFCO will maintain adequate runoff- and sediment-control facilities to protect local surface waters. SUFCO commits to mitigating any material damage resulting from subsiding perennial streams in the ~~permit~~lease area as indicated in Chapter 5 of this M&RP. The plan for protection of the perennial streams meets the BLM requirements for protection of their water rights (BLM, 1992).

Sedimentation Pond Sludge Plan. Sludge contained in the sediment ponds will be cleaned from the ponds and temporarily stockpiled upstream of the pond to allow water to drain from the sludge back into the pond. The sludge will be sampled for acid and toxic forming substances prior to be transported to the waste rock disposal site. Sedimentation pond sludge will be incorporated into the fill as described in Part 3.2.6 of Volume 3.

TABLE 7-2

Water Monitoring Program

Monitoring Wells	Protocol	Comments
US-80-2	A	Screened in Castlegate Sandstone
US-80-4	B	Screened in Castlegate Sandstone
89-20-2W	A	Screened in Castlegate Sandstone
US-79-13	B	Screened in Blackhawk Formation
US-81-3	A	Screened in Blackhawk Formation
US-81-4	A	Screened in Blackhawk Formation
01-8-1	A	Screened in Blackhawk Formation
Streams		
SUFCO 006	C,2	Upper South Fork Quitchupah Creek
SUFCO 006A	F,1	Upper South Fork Quitchupah Creek
SUFCO 006B	F,1	Upper South Fork Quitchupah Creek
SUFCO 007	C,2	Upper North Fork Quitchupah Creek
SUFCO 041	C,2	Lower Quitchupah Creek
SUFCO 042	C,2	Lower North Fork Quitchupah Creek
SUFCO 046	C,2	Upper Quitchupah Creek
SUFCO 047A	C,2	Lower East Spring Canyon Creek
SUFCO 090	C,1	Upper Box Canyon Creek
Pines 106	C,2	Upper East Fork Box Canyon
Pines 302	C,1	Muddy Creek-Last Water Creek Confluence
Pines 403	C,2	Lower Box Canyon Creek
Pines 405	C,1	Muddy Creek - Box Creek Confluence
Pines 406b*	C,1	Lower Muddy Creek
Pines 407	C,1	Box Canyon Creek
Pines 408	C,1	East Fork Box Canyon Creek
USFS-109	C,1	Upper Main Fork of Box Canyon Creek
Link 001	C,2	Link Canyon Drainage
Link 002	C,2	Link Canyon Drainage
FP-1	G,6	East Fork of Main Fork of Box Canyon
FP-2	G,6	East Fork of East Fork of Box Canyon
M-STR4	C,1	Cowboy Creek

*Monitoring point Pines 406 was moved downstream to the USGS monitoring point in 1999 and renumbered as Pines 406b. The point is located in the NW1/4NE1/4, Sec. 21, T21S. R6E.

TABLE 7-2 (Continued)

Water Monitoring Program

Springs	Protocol	Comments
SUFCO 001	D,3	Blackhawk Formation
SUFCO 047	D,4	Star Point Sandstone
SUFCO 057A	D,3	North Horn Formation
SUFCO 089	E,3	Castlegate Sandstone
GW-13	D,3	North Horn Formation
GW-20	D,5	Castlegate Sandstone
GW-21	D,3	Castlegate Sandstone
Pines 100	D,4	Castlegate Sandstone
Pines 105	D,3	Castlegate Sandstone
Pines 206	D,5	Blackhawk Formation
Pines 209	D,5	Blackhawk Formation
Pines 212	D,5	Blackhawk Formation
Pines 214	D,5	Blackhawk Formation
Pines 218	D,3	Castlegate Sandstone
Pines 303	D,3	Blackhawk Formation
Pines 310	D,7	Castlegate Sandstone
Pines 311	D,7	Castlegate Sandstone
Link Portal-West	D,4	Link Canyon Portal
Link Portal-East	D,4	Link Canyon Portal
M-SP01	D,3	Price River Formation
M-SP02	D,3	Price River Formation
M-SP08	D,3	North Horn Formation
M-SP18	D,3	Price River Formation
M-SP39	D,3	Price River Formation
M-SP53	D,3	North Horn Formation
Mud Spring	D,5	Price River Formation
Broad Hollow	D,5	Blackhawk Formation

plan, the parameter could be calculated if it were ever necessary to evaluate total hardness.

- Mayo does not believe that total alkalinity should be included in the operational monitoring plan. In the waters of Wasatch Plateau, total alkalinity is almost exclusively the product of bicarbonate and carbonate alkalinity. Both bicarbonate and carbonate alkalinity are included in the operational monitoring plans. Contributions to alkalinity from hydroxide, silicate, borate, and organic ligands are trivial.

- Mayo did not include dissolved iron and dissolved manganese in the operational monitoring plan because iron and manganese do not readily exist in dissolved form in basic (pH>7) waters but exist instead as hydroxide complexes. All waters in the ~~permit~~lease area are basic. Measurements of total iron and manganese quantify both the dissolved and complex forms of these elements.

Equipment, structures and other devices used in conjunction with monitoring the quality and quantity of groundwater in the permit and adjacent areas have been installed, maintained, and operated in accordance with accepted procedures. This equipment will be removed or properly abandoned by SUFCO when no longer needed.

Surface Water Monitoring. Surface water monitoring is conducted in the SUFCO Mine permit and adjacent areas based upon the monitoring plans contained in Tables 7-2 through 7-6. Surface water monitoring locations are identified in Plate 7-3. The parameters monitored meet the requirements of R645-301-731.222.1, 40 CFR 122 and 123, R645-301-751, and the applicable UPDES permits. These tables are based on studies done by Mayo (Appendices 7-17 and 7-18) and supersede previous plans. For clarification of the apparent discrepancies over the classification of stream-monitoring site 047A in the M&RP and the Mayo report (Appendix 7-17) which identified site 047A as a spring-monitoring site. SUFCO has always called the station a surface water monitoring site because samples are taken in a drainage. However, Mayo called this site a spring in their report and recommended monitoring plan. When Mayo first collected samples from the site, they were surprised to learn that water from this site had

Contributions to alkalinity from hydroxide, silicate, borate, and organic ligands are trivial.

- Mayo did not include dissolved iron and dissolved manganese in the operational monitoring plan because iron and manganese do not readily exist in dissolved form in basic (pH>7) waters but exist instead as hydroxide complexes. All waters in the ~~permit~~lease area are basic. Measurements of total iron and manganese quantify both the dissolved and complex forms of these elements.

Equipment, structures, and other devices used in conjunction with monitoring the quality and quantity of the surface water in the permit and adjacent areas have been installed, maintained, and operated in accordance with accepted procedures. This equipment will be removed by SUFCO when no longer needed.

Stock Water Ponds

Several stock watering ponds are located in the Pines Tract and Quitchupah Lease area. Surface cracking due to mining related subsidence within the Quitchupah Lease has apparently adversely affected a few of the ponds. Action has been taken by SUFCO in the past to mitigate the damage, including applying bentonitic seals to the pond floors and hauling water for livestock. However, ranchers and State and Federal agencies have erroneously claimed that subsidence has adversely affected several ponds outside of the mining areas. In order to more adequately monitor the effects of mining on the stock watering ponds, SUFCO has been negotiating with DOGM, USFS, and the local rancher's association to create a workable monitoring plan for the ponds that can be agreed upon by all participants. DOGM has taken the lead in this process, and as of May 2000, a plan had not yet been finalized. In the interim, SUFCO commits to visiting the ponds within the Pines Tract and Quitchupah Lease area as soon as they are accessible in the spring of each year (typically late April to early May), and 7-5A. The design topography and cross sections for the waste rock disposal site sedimentation pond are located in Volume 3 of this M&RP.

Other Cross Sections and Maps. Other relevant cross sections or maps are presented and discussed in Chapter 5 of this M&RP.

7.3.1.8 Water Rights and Replacement

Ground and surface water rights do exist within the Sufco Mine ~~permit~~lease area. Mitigation has been performed at stock pond locations where claims have been made that the available surface water has been impacted by subsidence. Mitigation at these locations has been performed by the placement of bentonite in the bottom of stock ponds and by hauling replacement water to the ponds for livestock use during summer months.

The Permittee will mitigate and replace the water supply of any land owner or adversely affected State appropriated water if such a water supply proves to be contaminated, diminished or interrupted as a result of mining operations. First, a determination will be made by the Division in accordance with R645-301-731.800 as to whether or not material damage has occurred. Then, in accordance with Regulation R645-301-525.510, the operator will correct any material damage resulting from subsidence caused to surface lands (which includes water rights), to the extent technologically and economically feasible. Negotiations will be held immediately with the impacted party to determine the appropriate mitigation activities. The restoration of water flows to impacted sources will be accomplished using the Best Technology Currently Available (BTCA). These activities may include, but not necessarily be limited to: piping or trucking water to the location of the loss; sealing surface fractures to prevent further losses (i.e., stream floors on bed rock or in shallow alluvium), and; construction of a ground water well and the installation of pumps to restore flows. If the above efforts are not successful, then the operator will explore the transferring of water rights to the injured party in flow equal to the determined loss and/or monetary reimbursement for proven material damages.

The water supply in the East Fork of Box Canyon is of special concern to Sufco and the regulatory authorities. In an effort to protect the minimal surface flows in this area, an intense monitoring and mitigation plan will be implemented prior to full extraction mining taking place under the East Fork. If changes in the quantity and quality of the water in the East Fork are noted, the Division will be immediately notified. A determination of the amount of water, if any,

APPENDIX 1-2

Lease Documents

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Utah State Office
P.O. Box 45155
Salt Lake City, UT 84145-0155
http://www.blm.gov

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
3432
SL-062583
UTU-47080
UTU-63214
(UT-923)

NOV 23 2009

CERTIFIED MAIL- Return Receipt Requested

DECISION

Canyon Fuel Company, LLC	:	
c/o Ark Land Company	:	Coal Lease
Attn: Scott L. Kehrer	:	SL-062583
City Place One, Suite 300	:	UTU-47080
St. Louis, MO 63141	:	UTU-63214

Coal Leases SL-062583, UTU-47080, and UTU-63214 Modified
Extension of Coverage of Surety Bond Accepted

Enclosed are copies of modified coal leases SL-062583, UTU-47080 and UTU-63214 effective on December 1, 2009. The terms and conditions of the original leases are made consistent with the laws, regulations, and lease terms applicable at the time of this modification. The anniversary dates of the coal leases remain September 11, 1941, October 1, 1981, and July 1, 1989, respectively.

On November 16, 2009 a surety rider submitted by Tara W. Mealer, an Attorney-in-Fact for the St. Paul Fire and Marine Insurance Company agreed to extend the coverage of the $1,600,000 LMU bond, No. 400SA1542, to include the additional modified acreage. This rider is acceptable to extend that coverage and is accepted as of the date of filing.

Please note that rental in the amount of $3.00 per acre, or fraction thereof, or a total of $9,240.00 for SL-062583, $5,862.00 for UTU-47080 and $32,088.00 for UTU-63214 will be due on the next anniversary date of these leases.

Roger L Bankert

Roger L. Bankert
Chief, Branch of Minerals

Enclosures:
3 Modified Coal Leases (9 pp. each)

cc: Price Coal Office
Mr. John Baza, Director, UDOGM, Box 145801, Salt Lake City, Utah 84114-5801
MMS, Solid Minerals Staff, MS 390B2, Box 25165, Denver, CO 80225

United States Department of the Interior
Bureau of Land Management
DIV OF LANDS & MINERALS
PO BOX 45155 ATTN:ACCOUNTS
SALT LAKE CITY, UT 84145 -0155
Phone: (801) 539-4006

Receipt	
No:	2035740

Transaction #: 2101045
Date of Transaction: 11/16/2009

CUSTOMER:	CANYON FUEL COMPANY LLC C/O ARK LAND COMPANY CITY PLACE ONE STE 300 ST LOUIS,MO 63141 US

LINE #	QTY	DESCRIPTION	REMARKS	UNIT PRICE	TOTAL
1	1.00	SUSPENSE, MISCELLANEOUS / SUSPENSE, MISCELLANEOUS / TEMPORARY HOLD (1 WEEK ONLY)	COAL MODIFICATION: SL0-62583,UTU-047080,UTU-063214 ADDITIONAL YEARLY RENTAL;	- n/a -	6948.00
2	1.00	SUSPENSE, MISCELLANEOUS / SUSPENSE, MISCELLANEOUS / TEMPORARY HOLD (1 WEEK ONLY)	FMV BONUS BID FOR SL0-062583,UTU-047080,UTU-063214 COAL MODIFICATIONS.	- n/a -	467000.00

TOTAL: $473,948.00

PAYMENT INFORMATION

1	AMOUNT:	6948.00	POSTMARKED:	11/15/2009
	TYPE:	CHECK	RECEIVED:	11/16/2009
	CHECK NO:	709757		
	NAME:	ARCH COAL INC CITY ONE PLACE DR STE 300 ST LOUIS MO 63141 US		
2	AMOUNT:	467000.00	POSTMARKED:	11/15/2009
	TYPE:	CHECK	RECEIVED:	11/16/2009
	CHECK NO:	709758		
	NAME:	ARCH COAL INC CITY ONE PLACE DR STE 300 ST LOUIS MO 63141 US		

REMARKS

CLIENT'S COPY

This receipt was generated by the automated BLM Collections and Billing System and is a paper representation of a portion of the official electronic record contained therein.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Serial No.___SL-062583_

MODIFIED COAL LEASE

Date of Lease_September 11, 1941___

PART I.

THIS MODIFIED COAL LEASE is entered into on ____________, by and between the **UNITED STATES OF AMERICA**, hereinafter called the Lessor, through the Bureau of Land Management, and

Canyon Fuel Company LLC
c/o Ark Land Company
City Place One, Suite 300
St. Louis, MO 63141

hereinafter called Lessee.

This modified lease shall retain the effective date of September 11, 1941 , of the original **COAL LEASE SL-062583**, and is effective for a period of 10 years from the date of the last lease readjustment, dated September 11, 2001 and for so long thereafter as coal is produced in commercial quantities from the leased lands, subject to readjustment of lease terms at the end of each 10 year lease period thereafter.

Sec. 1. This lease is issued pursuant and subject to the terms and provisions of the: (NOTE: Check the appropriate Act or Acts.)

XX Mineral Lands Leasing Act of 1920, as amended, 41 Stat. 437, 30 U.S.C. 181-287, hereinafter referred to as the Act;

_ Mineral Leasing Act for Acquired Lands of 1947, 61 Stat. 913, 30 U.S.C. 351-359;

and to the regulations and formal orders of the Secretary of the Interior which are now or hereafter in force, when not inconsistent with the express and specific provisions herein.

Sec. 2. Lessee as the holder of Coal Lease SL- 062583, issued effective September 11, 1941 , was granted the exclusive right and privilege to drill for, mine, extract, remove or otherwise process and dispose of the coal deposits in, upon, or under the lands described below as Tract 1.

The Lessor in consideration of fair market value, rents and royalties to be paid, and the conditions and covenants to be observed as herein set forth, hereby grants and leases to Lessee the exclusive right and privilege to drill for, mine, extract, remove, or otherwise process and dispose of the coal deposits in, upon, or under the lands described below as Tract 2.

Tract 1:
T. 21 S., R. 4 E., SLM, Utah
Sec. 36, S½;

T. 22 S., R. 5 E., SLM, Utah
Sec. 31, all;

T. 22 S. R. 4 E., SLM, Utah
Sec. 1, lots 1-4, S½N½, S½;

T. 22 S., R. 5 E., SLM, Utah
Sec. 6, all;
Sec. 7, N½NE¼, E½NW¼.

Tract 2:
T. 22 S., R. 4 E., SLM, Utah
Sec. 2, SE¼, S½SW¼;
Sec. 3, SE¼SE¼;
Sec. 10, E½NE¼, NE¼SE¼;
Sec. 11, N½, N½S½.

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NOV 16 2009
BUREAU OF LAND MANAGEMENT

containing 3,079.83 acres, more or less, together with the right to construct such works, buildings, plants, structures, equipment and appliances and the right to use such on-lease rights-of-way which may be necessary and convenient in the exercise of the rights and privileges granted, subject to the conditions herein provided.

Part II. TERMS AND CONDITIONS

Sec. 1.(a) RENTAL RATE - Lessee shall pay Lessor rental annually and in advance for each acre or fraction thereof during the continuance of the lease at the rate of $3.00 per acre for each lease year.

(b) RENTAL CREDITS - Rental shall not be credited against either production or advance royalties for any year.

Sec. 2.(a) PRODUCTION ROYALTIES - The royalty shall be 8 percent of the value of the coal as set forth in the regulations. Royalties are due to Lessor the final day of the month succeeding the calendar month in which the royalty obligation accrues.

(b) ADVANCE ROYALTIES - Upon request by the Lessee, the authorized officer may accept, for a total of not more than 20* years, the payment of advance royalties in lieu of continued operation, consistent with the regulations. The advance royalty shall be based on a percent of the value of a minimum number of tons determined in the manner established by the advance royalty regulations in effect at the time the Lessee requests approval to pay advance royalties in lieu of continued operation.

* 20 years (Public Law 109-58)

Sec. 3. BONDS - Lessee shall maintain in the proper office a bond in the amount of $1,600,000 if lands are added to the existing LMU. The authorized officer may require an increase in this amount when additional coverage is determined appropriate.

Sec. 4. DILIGENCE - This lease achieved diligent development February 1, 2003 , and is subject to the conditions of continued operation. Continued operation may be excused when operations under the lease are interrupted by strikes, the elements, or casualties not attributable to the Lessee. The Lessor, in the public interest, may suspend the condition of continued operation upon payment of advance royalties in accordance with the regulations in existence at the time of the suspension.

The Lessor reserves the power to assent to or order the suspension of the terms and conditions of this lease in accordance with, inter alia, Section 39 of the Mineral Leasing Act, 30 U.S.C. 209.

Sec. 5. **LOGICAL MINING UNIT (LMU)** – Either upon approval by the Lessor of the Lessee's application or at the direction of the Lessor, this lease shall become an LMU or part of an LMU, subject to the provisions set forth in the regulations.

The stipulations established in an LMU approval in effect at the time of LMU approval or modification will supersede the relevant inconsistent terms of this lease so long as the lease remains committed to the LMU. If the LMU of which this lease is a part is dissolved, the lease shall then be subject to the lease terms which would have been applied if the lease had not been included in an LMU.

This lease was placed in the SUFCO LMU effective April 2, 1990.

Sec. 6. DOCUMENTS, EVIDENCE AND INSPECTION - At such times and in such form as Lessor may prescribe, Lessee shall furnish detailed statements showing the amounts and quality of all products removed and sold from the lease, the proceeds therefrom, and the amount used for production purposes or unavoidably lost.

Lessee shall keep open at all reasonable times for the inspection of any duly authorized officer of Lessor, the leased premises and all surface and underground improvements, works, machinery, ore stockpiles, equipment, and all books, accounts, maps, and records relative to operations, surveys, or investigations on or under the leased lands.

Lessee shall allow Lessor access to and copying of documents reasonably necessary to verify Lessee compliance with terms and conditions of the lease.

While this lease remains in effect, information obtained under this section shall be closed to inspection by the public in accordance with the Freedom of Information Action (5 U.S.C. 552).

Sec. 7. DAMAGES TO PROPERTY AND CONDUCT OF OPERATIONS - Lessee shall comply at its own expense with all reasonable orders of the Secretary, respecting diligent operations, prevention of waste, and protection of other resources.

Lessee shall not conduct exploration operations, other than casual use, without an approved exploration plan. All exploration plans prior to the commencement of mining operations within an approved mining permit area shall be submitted to the authorized officer.

Lessee shall carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health, or property, and prevention of waste, damage or degradation any land, air, water, cultural, biological, visual, and other resources, including mineral deposits and formations of mineral deposits not leased hereunder, and to other land uses or users. Lessee shall take measures deemed necessary by Lessor to accomplish the intent of this lease term. Such measures may include, but not limited to, modification to proposed siting or design of facilities, timing of operations, and specifications of interim and final reclamation procedures. Lessor reserves to itself the right to lease, sell, or otherwise dispose of the surface or other mineral deposits in the lands and the right to continue existing uses and to authorize future uses upon or in the leased lands, including issuing leases for mineral deposits not covered hereunder and approving easements or rights-of-way. Lessor shall condition such uses to prevent unnecessary or unreasonable interference with rights of Lessee as may be consistent with concepts of multiple use and multiple mineral development.

Sec. 8 **PROTECTION OF DIVERSE INTERESTS, AND EQUAL OPPORTUNITY** - Lessee shall: pay when due all taxes legally assessed and levied under the laws of the State or the United States; accord all employees complete freedom of purchase; pay all wages at least twice each month in lawful money of the United States; maintain a safe working environment in accordance with standard industry practices; restrict the workday to not more than 8 hours in any one day for underground workers, except in emergences; and take measures necessary to protect the health and safety of the public. No person under the age of 16 years shall be employed in any mine below the surface. To the extent that laws of the State in which the lands are situated are more restrictive than the provisions in this paragraph, then the State laws apply.

Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor. Neither Lessee nor Lessee's subcontractors shall maintain segregated facilities.

Sec. 9.(a) **TRANSFERS**
(Check the appropriate space)

X This lease may be transferred in whole or in part to any person, association or corporation qualified to hold such lease interest.

___ This lease may be transferred in whole or in part to another public body, or to a person who will mine the coal on behalf of, and for the use of, the public body or to a person who for the limited purpose of creating a security interest in favor of a lender agrees to be obligated to mine the coal on behalf of the public body.

___ This lease may only be transferred in whole or in part to another small business qualified under 13 CFR 121.

Transfers of record title, working or royalty interest must be approved in accordance with the regulations.

(b) **RELINQUISHMENTS** - The Lessee may relinquish in writing at any time all rights under this lease or any portion thereof as provided in the regulations. Upon Lessor's acceptance of the relinquishment, Lessee shall be relieved of all future obligations under the lease or the relinquished portion thereof, whichever is applicable.

Sec. 10. **DELIVERY OF PREMISES, REMOVAL OF MACHINERY, EQUIPMENT, ETC.** - At such times as all portions of this lease are returned to Lessor, Lessee shall deliver up to Lessor the land leased, underground timbering, and such other supports and structures necessary for the preservation of the mine workings on the leased premises or deposits and place all workings in condition for suspension or abandonment. Within 180 days thereof, Lessee shall remove from the premises all other structures, machinery, equipment, tools, and materials that it elects to or as required by the authorized officer. Any such structures, machinery, equipment, tools, and materials remaining on the leased lands beyond 180 days, or approved extension thereof, shall become the property of the Lessor, but Lessee shall either remove any or all such property or shall continue to be liable for the cost of removal and disposal in the amount actually incurred by the Lessor. If the surface is owned by third parties, Lessor shall waive the requirement for removal, provided the third parties do not object to such waiver. Lessee shall, prior to the termination of bond liability or at any other time when required and in accordance with all applicable laws and regulations, reclaim all lands the surface of which has been disturbed, dispose of all debris or solid waste, repair the offsite and onsite damage caused by Lessee's activity or activities incidental thereto, and reclaim access roads or trails.

Sec. 11. **PROCEEDINGS IN CASE OF DEFAULT** -

If Lessee fails to comply with applicable laws, existing regulations, or the terms, conditions and stipulations of this lease, and the noncompliance continues for 30 days after written notice thereof, this lease shall be subject to cancellation by the Lessor only by judicial proceedings. This provision shall not be construed to prevent the exercise by Lessor of any other legal and equitable remedy, including waiver of the default. Any such remedy or waiver shall not prevent later cancellation for the same default occurring at any other time.

Sec. 12. **HEIRS AND SUCCESSORS - IN-INTEREST** - Each obligation of this lease shall extend to and be binding upon, and every benefit hereof shall insure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 13. **INDEMNIFICATION** - Lessee shall indemnify and hold harmless the United States from any and all claims arising out of the Lessee's activities and operations under this lease.

Sec. 14. **SPECIAL STATUTES** - This lease is subject to the Federal Water Pollution Control Act (33 U.S.C. 1151 - 1175); the Clean Air Act (42 U.S.C. 1857 et seq.), and to all other applicable laws pertaining to exploration activities, mining operations and reclamation, including the Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et seq.)

Sec. 15. **SPECIAL STIPULATIONS** -

SEE ATTACHED STIPULATIONS

	The United States of America
Canyon Fuel Company, LLC.	BY Roger L. Bankert
Company or Lessee Name	
L E D'Andrea	Roger L Bankert
(Signature of Lessee)	(Signing Officer)
President	Chief, Branch of Minerals
(Title)	(Title)
11/10/09	11/23/09
(Date)	(Date)

Title 18 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

SPECIAL STIPULATIONS FOR UTU-63214
MODIFIED COAL LEASE

1. The Regulatory Authority shall mean the State Regulatory Authority pursuant to a cooperative agreement approved under 30 CFR Part 745 or in the absence of a cooperative agreement, Office of Surface Mining. The authorized officer (AO) shall mean the State Director, Bureau of Land Management. The AO of the Surface Management Agency shall mean the Forest Supervisor, Forest Service. Surface Management Agency for private surface is the Bureau of Land Management. For adjoining private lands with Federal minerals and which primarily involve National Forest Service issues, the Forest Service will have the lead for environmental analysis and when necessary, documentation in an environmental analysis and, when necessary, documentation in an environmental assessment or environmental impact statement.

2. The AO, of the Bureau of Land Management, Office of Surface Mining (Regulatory Authority) and the Surface Management Agency (Forest Service) respectively, shall coordinate, as practical, regulation of mining operations and associated activities on the lease area.

3. In accordance with Sec. 523 (b) of the "Surface Mining Control and Reclamation Act of 1977," surface mining and reclamation operations conducted on this lease are to conform with the requirements of this Act and are subject to compliance with the Office of Surface Mining Regulations, or as applicable, a Utah program equivalent approved under cooperative agreement in accordance with Sec. 523(c). the United States Government does not warrant that the entire tract will be susceptible to mining.

4. Federal Regulations 43 CFR 3400 pertaining to Coal Management make provisions for the Surface Management Agency, the surface of which is under the jurisdiction of any Federal agency other than the Department of Interior, to consent to leasing and to prescribe conditions to insure the use and protection of the lands. All or part of this lease contains lands the surface of which are managed by the United States Department of Agriculture, Forest Service, Fishlake National Forest.

The following stipulations pertain to the Lessee responsibility for mining operations on the lease area and on adjacent areas as may be specifically designated on National Forest System lands.

5. Before undertaking activities that may disturb the surface of previously undisturbed leased lands, the lessee may be required to conduct a cultural resource inventory and a paleontological appraisal of the areas to be disturbed. These studies shall be conducted by qualified professional cultural resource specialists or qualified paleontologists, as appropriate, and a report prepared itemizing the findings. A plan will then be submitted making recommendations for the protection of, or measures to be taken to mitigate impacts for identified cultural or paleontological resources.
If cultural resources or paleontological remains (fossils) of significant scientific interest are discovered during operations under this lease, the lessee prior to disturbance shall, immediately bring them to the attention of the appropriate authorities. Paleontological remains of significant scientific interest do not include leaves, ferns, or dinosaur tracks commonly encountered during underground mining operations.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

6. If there is reason to believe that Threatened or Endangered (T&E) species of plants or animals, or migratory bird species of high Federal interest occur in the area, the Lessee shall be required to conduct an intensive field inventory of the area to be disturbed and/or impacted. The inventory shall be conducted by a qualified specialist and a report of findings will be prepared. A plan will be prepared making recommendations for the protection of these species or action necessary to mitigate the disturbance.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

7. The Lessee shall be required to perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. Existing data may be used if such data are adequate for the intended purposes. The study shall be adequate to locate, quantify, and demonstrate the interrelationship of the geology, topography, surface and ground water hydrology, vegetation and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison.

8. Powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to provide adequate protection for raptors and other large birds. When feasible, powerlines will be located at least 100 yards from public roads.

9. The limited area available for mine facilities at the coal outcrop, steep topography, adverse winter weather, and physical limitations on the size and design of the access road, are factors which will determine the ultimate size of the surface area utilized for the mine. A site specific environmental analysis will be prepared for each new mine site development and for major modifications to existing developments to examine alternatives and mitigate conflicts.

10. Consideration will be given to site selection to reduce adverse visual impacts. Where alternative sites are available, and each alternative is technically feasible, the alternative involving the least damage to the scenery and other resources shall be selected. Permanent structures and facilities will be designed, and screening techniques employed, to reduce visual impacts, and where possible achieve a final landscape compatible with the natural surroundings. The creation of unusual, objectionable, or unnatural land forms and vegetative landscape features will be avoided.

11. The Lessee shall be required to establish a monitoring system to locate, measure, and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the lease area. The monitoring shall incorporate and be an extension of the baseline data.

12. The lessee shall provide for the suppression and control of fugitive dust on haul roads and at coal handling and storage facilities. On Forest Development Roads (FDR), lessees may perform their share of road maintenance by a commensurate share agreement if a significant degree of traffic is generated that is not related to their activities.

13. Except at specifically approved locations, underground mining operations shall be conducted in such a manner so as to prevent surface subsidence that would: (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides, (2) cause damage to existing surface structures, and (3) damage or alter the flow of perennial streams. The lessee shall provide specific measures for the protection of escarpments, and determine corrective measures to assure that hazardous conditions are not created.

14. In order to avoid surface disturbance on steep canyon slopes and to preclude the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specifically approved locations.

15. If removal of timber is required for clearing of construction sites, etc., such timber shall be removed in accordance with the regulations of the surface management agency.

16. The coal contained within, and authorized for mining under this lease, shall be extracted only by underground mining methods.

17. Existing Forest Service owned or permitted surface improvements will need to be protected, restored, or replaced to provide for the continuance of current land uses.

18. In order to protect big game wintering areas, elk calving and deer fawning areas, sagegrouse strutting areas, and other critical wildlife habitat and/or activities, specific surface uses outside the mine development area may be curtailed during specific periods of the year.

19. Support facilities, structures, equipment, and similar developments will be removed from the lease area within 2 years after the final termination of use of such facilities. This provision shall apply unless the requirement of Section 10 of the lease form is applicable. Disturbed areas and those areas previously occupied by such facilities will be stabilized and rehabilitated, drainages reestablished, and the areas returned to a premining land use.

20. The Lessee at the conclusion of the mining operation, or at other times as surface disturbance related to mining may occur, will replace all damaged, disturbed, or displaced corner monuments (section corners, quarter corners, etc.) their accessories and appendages (witness trees, bearing trees, etc.), or restore them to their original condition and location, or at other locations that meet the requirements of the rectangular surveying system. This work shall be conducted at the expense of the Lessee, by BLM to the standards and guidelines found in the Manual of Surveying Instructions, U.S. Department of Interior.

21. The Lessee, at his expense, will be responsible to replace any surface and/or developed ground water sources identified for protection, that may be lost or adversely affected by mining operations, with water from an alternate source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, livestock and wildlife use, or other land uses (authorized by 36 CFR 251).

22. The Licensee/Permittee/Lessee must comply with all the rules and regulations of the Secretary of Agriculture set forth at Title 36, Chapter II, of the Code of Federal Regulations governing the use and management of the National Forest System (NFS) when not inconsistent with the rights granted by the Secretary of the Interior in the license/permit/lease. The Secretary of Agriculture's rules and regulations must be complied with for (1) all use and occupancy of the NFS prior to approval of a permit/operation plan by the Secretary of Interior, (2) uses of all existing improvements, such as Forest Development Roads, within and outside the area licensed, permitted or leased by the Secretary of Interior, and (3) use and occupancy of the NFS not authorized by a permit/operation plan approved by the Secretary of the Interior.

All matters related to this stipulation are to be addressed to:

Forest Supervisor
Fishlake National Forest
115 East 900 North
Richfield, Utah 84701

Telephone No.: 435-896-9233

who is the authorized representative of the Secretary of Agriculture.

23. Notwithstanding the approval of a resource recovery and protection plan by the BLM, lessor reserves the right to seek damages against the operator/lessee in the event (I) the operator/lessee fails to achieve maximum economic recovery [as defined at 43 CFR §3480.0-5(21)] of the recoverable coal reserves or (ii) the operator/lessee is determined to have caused a wasting of recoverable coal reserves. Damages shall be measured on the basis of the royalty that would have been payable on the wasted or unrecovered coal.

The parties recognize that under an approved R2P2, conditions may require a modification by the operator/lessee of that plan. In the event a coal bed or portion thereof is not to be mined or is rendered unminable by the operation, the operator shall submit appropriate justification to obtain approval by the AO to leave such reserves unmined. Upon approval by the AO, such coal beds or portions thereof shall not be subject to damages as described above. Further, nothing in this section shall prevent the operator/lessee from exercising its right to relinquish all or a portion of the lease as authorized by statute and regulation.

In the event the AO determines that the R2P2 modification will not attain MER resulting from changed conditions, the AO will give proper notice to the operator/lessee as required under applicable regulations. The AO will order a new R2P2 modification if necessary, identifying additional reserves to be mined in order to attain MER. Upon a final administrative or judicial ruling upholding such an ordered modification, any reserves left unmined (wasted) under that plan will be subject to damages as described in the first paragraph under this section.

Subject to the right to appeal hereinafter set forth, payment of the value of the royalty on such unmined recoverable coal reserves shall become due and payable upon determination by the AO that the coal reserves have been rendered unminable or at such time that the lessee has demonstrated an unwillingness to extract the coal.

The BLM may enforce this provision either by issuing a written decision requiring payment of the MMS demand for such royalties, or by issuing a notice of non-compliance. A decision or notice of non-compliance issued by the lessor that payment is due under this stipulation is appealable as allowed by law.

24. WASTE CERTIFICATION: The Lessee shall provide upon abandonment, transfer of operation, assignment of rights, sealing off a mined area and prior to lease relinquishment, certification to the lessor that, based upon a complete search of all the records for the lease and its associated mine operation(s), and upon Lessee's and the operator's knowledge of past mining operations associated with the lease, there has been no reportable quantities of **hazardous substances** per (40 CFR 302.4) or **used oil** [as per Utah State Management Rule R-315-15], discharged, deposited or released within the lease, either on the surface or underground, and that all remedial actions necessary have been taken to protect human health and the environment with respect to any such substances. Lessee must additionally provide to the Lessor a complete list of all hazardous substances and hazardous materials and their Chemical Abstract Registry Numbers, and the oil and petroleum products used or stored on, or delivered to, the lease. Such disclosure will be in addition to any other disclosure required by law or agreement.

25. UNDERGROUND INSPECTION: All safe and accessible areas shall be inspected prior to being sealed. The lessee shall notify the Authorized Officer in writing 30 days prior to the sealing of any areas in the mine and state the reason for closure. Prior to seals being put into place, the lessee shall inspect the area and document any equipment/machinery, hazardous substances, and used oil that is to be left underground. The AO may participate in this inspection.

The purpose of this inspection will be: (1) to provide documentation for compliance with 42 U.S.C. 9620 section 120(h) and Utah State Management Rule R-315-15, and to assure that certification will be meaningful at the time of lease relinquishment, (2) to document the inspection with a mine map showing location of equipment/machinery (model, type of fluid, amount remaining, batteries etc.) that is proposed to be left underground. In addition, these items will be photographed at the Lessee's expense and shall be submitted to the Authorized Officer as part of the certification. The abandonment of any equipment/machinery shall be on a case by case basis and shall not be accomplished unless the Authorized Officer has granted a written approval. Any on-lease disposal of non-coal waste must comply with 30 CFR §817.89.

26. GOB VENT BOREHOLES. The Lessee shall submit a gob vent borehole plan for approval by the AO as part of an R2P2 for all gob vent boreholes. The plugging portion of the plan must meet 43 CFR 3484.1(a)(3) as a minimum. If variations to the approved plugging procedures are necessary, they shall also be approved by the AO in writing prior to implementation of the procedures.

27. FAIR MARKET VALUE BONUS: Pursuant to 43 CFR 3432.2(c), "the lands applied for shall be added to the existing lease without competitive bidding, but the United States shall receive the fair market value of the lease of the added lands, either by cash payment or adjustment of the royalty applicable to the lands added to the lease by the modification." Therefore, the lessee will pay the fair market value (FMV) bonus payment for the coal resources mined in the area of Federal coal lease modification (SL-062583) Tract 2, in the amount of $155,667, prior to approval of the modification adding Tract 2 to lease SL-062583. A payment of $159,333 will be due prior to one year anniversary of the approval of the modification and a final payment of $163,333 will be required to be paid prior to the second year anniversary of the approval of the modification. Finally, an additional bonus payment will be due for the coal resources mined on the areas comprised of Federal coal lease modification acreage added to coal leases SL- 062583 (Tract 2), UTU-47080 (Tract 2) and UTU-63214 (Tract 3), which exceed 6,930,000 tons mined, at a rate of $.35 per ton for the actual tonnage mined, adjusted annually using the U. S. Bureau of Labor Statistics CPI West Urban Energy Index; or if that index is not available an index that is mutually agreed to by the lessee and the authorized officer will be used. . Payment of this part of the FMV at the specified rate and tonnage mined will be on the schedule required for payment of production royalties to the Minerals Management Service (MMS). The lessee will clearly indicate which portion of the payment is for royalty and what is for the lease bonus payment.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Serial No.___UTU-47080_

MODIFIED COAL LEASE

Date of Lease_October 1, 1981___

PART I.

THIS MODIFIED COAL LEASE is entered into on ____________, by and between the **UNITED STATES OF AMERICA**, hereinafter called the Lessor, through the Bureau of Land Management, and

Canyon Fuel Company LLC
c/o Ark Land Company
City Place One, Suite 300
St. Louis, MO 63141

hereinafter called Lessee.

This modified lease shall retain the effective date of October 1, 1981 , of the original **COAL LEASE UTU-47080**, and is effective for a period of 10 years from the date of the last lease readjustment, dated October 1, 2001 and for so long thereafter as coal is produced in commercial quantities from the leased lands, subject to readjustment of lease terms at the end of each 10 year lease period thereafter.

Sec. 1. This lease is issued pursuant and subject to the terms and provisions of the: (NOTE: Check the appropriate Act or Acts.)

XX Mineral Lands Leasing Act of 1920, as amended, 41 Stat. 437, 30 U.S.C. 181-287, hereinafter referred to as the Act;

_ Mineral Leasing Act for Acquired Lands of 1947, 61 Stat. 913, 30 U.S.C. 351-359;

and to the regulations and formal orders of the Secretary of the Interior which are now or hereafter in force, when not inconsistent with the express and specific provisions herein.

Sec. 2. Lessee as the holder of Coal Lease UTU- 47080, issued effective October 1, 1981 , was granted the exclusive right and privilege to drill for, mine, extract, remove or otherwise process and dispose of the coal deposits in, upon, or under the lands described below as Tract 1.

The Lessor in consideration of fair market value, rents and royalties to be paid, and the conditions and covenants to be observed as herein set forth, hereby grants and leases to Lessee the exclusive right and privilege to drill for, mine, extract, remove, or otherwise process and dispose of the coal deposits in, upon, or under the lands described below as Tract 2.

Tract 1:
T. 21 S., R. 4 E., SLM, Utah
Sec. 25, all;
Sec. 36, N½;

T. 21 S. R. 5 E., SLM, Utah
Sec. 30, lots 2-4, W½SE¼;

Tract 2:
T. 21 S., R. 4 E., SLM, Utah
Sec. 35, E½, E½SW¼;

T. 22 S., R. 4 E., SLM, Utah
Sec. 2, lots 1-4, S½NE¼, S½NW¼, N½SW¼;
Sec. 3, NE¼SE¼.

containing 1,953.73 acres, more or less, together with the right to construct such works, buildings, plants, structures, equipment and appliances and the right to use such on-lease rights-of-way which may be necessary and convenient in the exercise of the rights and privileges granted, subject to the conditions herein provided.

Part II. TERMS AND CONDITIONS

Sec. 1.(a) RENTAL RATE - Lessee shall pay Lessor rental annually and in advance for each acre or fraction thereof during the continuance of the lease at the rate of $3.00 per acre for each lease year.

(b) RENTAL CREDITS - Rental shall not be credited against either production or advance royalties for any year.

Sec. 2.(a) PRODUCTION ROYALTIES - The royalty shall be 8 percent of the value of the coal as set forth in the regulations. Royalties are due to Lessor the final day of the month succeeding the calendar month in which the royalty obligation accrues.

(b) ADVANCE ROYALTIES - Upon request by the Lessee, the authorized officer may accept, for a total of not more than 20* years, the payment of advance royalties in lieu of continued operation, consistent with the regulations. The advance royalty shall be based on a percent of the value of a minimum number of tons determined in the manner established by the advance royalty regulations in effect at the time the Lessee requests approval to pay advance royalties in lieu of continued operation.

* 20 years (Public Law 109-58)

Sec. 3. BONDS - Lessee shall maintain in the proper office a bond in the amount of $1,600,000 if lands are added to the existing LMU. The authorized officer may require an increase in this amount when additional coverage is determined appropriate.

Sec. 4. DILIGENCE - This lease achieved diligent development February 1, 2003 , and is subject to the conditions of continued operation. Continued operation may be excused when operations under the lease are interrupted by strikes, the elements, or casualties not attributable to the Lessee. The Lessor, in the public interest, may suspend the condition of continued operation upon payment of advance royalties in accordance with the regulations in existence at the time of the suspension.

The Lessor reserves the power to assent to or order the suspension of the terms and conditions of this lease in accordance with, inter alia, Section 39 of the Mineral Leasing Act, 30 U.S.C. 209.

Sec. 5. **LOGICAL MINING UNIT (LMU)** – Either upon approval by the Lessor of the Lessee's application or at the direction of the Lessor, this lease shall become an LMU or part of an LMU, subject to the provisions set forth in the regulations.

The stipulations established in an LMU approval in effect at the time of LMU approval or modification will supersede the relevant inconsistent terms of this lease so long as the lease remains committed to the LMU. If the LMU of which this lease is a part is dissolved, the lease shall then be subject to the lease terms which would have been applied if the lease had not been included in an LMU.
This lease was placed in the SUFCO LMU effective April 2, 1990.

Sec. 6. DOCUMENTS, EVIDENCE AND INSPECTION - At such times and in such form as Lessor may prescribe, Lessee shall furnish detailed statements showing the amounts and quality of all products removed and sold from the lease, the proceeds therefrom, and the amount used for production purposes or unavoidably lost.

Lessee shall keep open at all reasonable times for the inspection of any duly authorized officer of Lessor, the leased premises and all surface and underground improvements, works, machinery, ore stockpiles, equipment, and all books, accounts, maps, and records relative to operations, surveys, or investigations on or under the leased lands.

Lessee shall allow Lessor access to and copying of documents reasonably necessary to verify Lessee compliance with terms and conditions of the lease.

While this lease remains in effect, information obtained under this section shall be closed to inspection by the public in accordance with the Freedom of Information Action (5 U.S.C. 552).

Sec. 7. DAMAGES TO PROPERTY AND CONDUCT OF OPERATIONS - Lessee shall comply at its own expense with all reasonable orders of the Secretary, respecting diligent operations, prevention of waste, and protection of other resources.

Lessee shall not conduct exploration operations, other than casual use, without an approved exploration plan. All exploration plans prior to the commencement of mining operations within an approved mining permit area shall be submitted to the authorized officer.

Lessee shall carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health, or property, and prevention of waste, damage or degradation any land, air, water, cultural, biological, visual, and other resources, including mineral deposits and formations of mineral deposits not leased hereunder, and to other land uses or users. Lessee shall take measures deemed necessary by Lessor to accomplish the intent of this lease term. Such measures may include, but not limited to, modification to proposed siting or design of facilities, timing of operations, and specifications of interim and final reclamation procedures. Lessor reserves to itself the right to lease, sell, or otherwise dispose of the surface or other mineral deposits in the lands and the right to continue existing uses and to authorize future uses upon or in the leased lands, including issuing leases for mineral deposits not covered hereunder and approving easements or rights-of-way. Lessor shall condition such uses to prevent unnecessary or unreasonable interference with rights of Lessee as may be consistent with concepts of multiple use and multiple mineral development.

Sec. 8 **PROTECTION OF DIVERSE INTERESTS, AND EQUAL OPPORTUNITY** - Lessee shall: pay when due all taxes legally assessed and levied under the laws of the State or the United States; accord all employees complete freedom of purchase; pay all wages at least twice each month in lawful money of the United States; maintain a safe working environment in accordance with standard industry practices; restrict the workday to not more than 8 hours in any one day for underground workers, except in emergences; and take measures necessary to protect the health and safety of the public. No person under the age of 16 years shall be employed in any mine below the surface. To the extent that laws of the State in which the lands are situated are more restrictive than the provisions in this paragraph, then the State laws apply.

Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor. Neither Lessee nor Lessee's subcontractors shall maintain segregated facilities.

Sec. 9.(a) **TRANSFERS**
(Check the appropriate space)

_X_ This lease may be transferred in whole or in part to any person, association or corporation qualified to hold such lease interest.

___ This lease may be transferred in whole or in part to another public body, or to a person who will mine the coal on behalf of, and for the use of, the public body or to a person who for the limited purpose of creating a security interest in favor of a lender agrees to be obligated to mine the coal on behalf of the public body.

___ This lease may only be transferred in whole or in part to another small business qualified under 13 CFR 121.

Transfers of record title, working or royalty interest <u>must</u> be approved in accordance with the regulations.

(b) **RELINQUISHMENTS** - The Lessee may relinquish in writing at any time all rights under this lease or any portion thereof as provided in the regulations. Upon Lessor's acceptance of the relinquishment, Lessee shall be relieved of all future obligations under the lease or the relinquished portion thereof, whichever is applicable.

Sec. 10. **DELIVERY OF PREMISES, REMOVAL OF MACHINERY, EQUIPMENT, ETC.** - At such times as all portions of this lease are returned to Lessor, Lessee shall deliver up to Lessor the land leased, underground timbering, and such other supports and structures necessary for the preservation of the mine workings on the leased premises or deposits and place all workings in condition for suspension or abandonment. Within 180 days thereof, Lessee shall remove from the premises all other structures, machinery, equipment, tools, and materials that it elects to or as required by the authorized officer. Any such structures, machinery, equipment, tools, and materials remaining on the leased lands beyond 180 days, or approved extension thereof, shall become the property of the Lessor, but Lessee shall either remove any or all such property or shall continue to be liable for the cost of removal and disposal in the amount actually incurred by the Lessor. If the surface is owned by third parties, Lessor shall waive the requirement for removal, provided the third parties do not object to such waiver. Lessee shall, prior to the termination of bond liability or at any other time when required and in accordance with all applicable laws and regulations, reclaim all lands the surface of which has been disturbed, dispose of all debris or solid waste, repair the offsite and onsite damage caused by Lessee's activity or activities incidental thereto, and reclaim access roads or trails.

Sec. 11. **PROCEEDINGS IN CASE OF DEFAULT** - If Lessee fails to comply with applicable laws, existing regulations, or the terms, conditions and stipulations of this lease, and the noncompliance continues for 30 days after written notice thereof, this lease shall be subject to cancellation by the Lessor only by judicial proceedings. This provision shall not be construed to prevent the exercise by Lessor of any other legal and equitable remedy, including waiver of the default. Any such remedy or waiver shall not prevent later cancellation for the same default occurring at any other time.

Sec. 12. **HEIRS AND SUCCESSORS - IN-INTEREST** - Each obligation of this lease shall extend to and be binding upon, and every benefit hereof shall insure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 13. **INDEMNIFICATION** - Lessee shall indemnify and hold harmless the United States from any and all claims arising out of the Lessee's activities and operations under this lease.

Sec. 14. **SPECIAL STATUTES** - This lease is subject to the Federal Water Pollution Control Act (33 U.S.C. 1151 - 1175); the Clean Air Act (42 U.S.C. 1857 et seq.), and to all other applicable laws pertaining to exploration activities, mining operations and reclamation, including the Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et seq.)

Sec. 15. **SPECIAL STIPULATIONS** -

SEE ATTACHED STIPULATIONS

The United States of America

Canyon Fuel Company, LLC.

Company or Lessee Name

BY Roger L. Bankert

(Signature of Lessee)

Roger L. Bankert

(Signing Officer)

President

(Title)

Chief, Branch of Minerals

(Title)

11/10/09

(Date)

11/23/09

(Date)

Title 18 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

SPECIAL STIPULATIONS FOR UTU-47080
MODIFIED COAL LEASE

1. The Regulatory Authority shall mean the State Regulatory Authority pursuant to a cooperative agreement approved under 30 CFR Part 745 or in the absence of a cooperative agreement, Office of Surface Mining. The authorized officer (AO) shall mean the State Director, Bureau of Land Management. The AO of the Surface Management Agency shall mean the Forest Supervisor, Forest Service. Surface Management Agency for private surface is the Bureau of Land Management. For adjoining private lands with Federal minerals and which primarily involve National Forest Service issues, the Forest Service will have the lead for environmental analysis and when necessary, documentation in an environmental analysis and, when necessary, documentation in an environmental assessment or environmental impact statement.

2. The AO, of the Bureau of Land Management, Office of Surface Mining (Regulatory Authority) and the Surface Management Agency (Forest Service) respectively, shall coordinate, as practical, regulation of mining operations and associated activities on the lease area.

3. In accordance with Sec. 523 (b) of the "Surface Mining Control and Reclamation Act of 1977," surface mining and reclamation operations conducted on this lease are to conform with the requirements of this Act and are subject to compliance with the Office of Surface Mining Regulations, or as applicable, a Utah program equivalent approved under cooperative agreement in accordance with Sec. 523(c). the United States Government does not warrant that the entire tract will be susceptible to mining.

4. Federal Regulations 43 CFR 3400 pertaining to Coal Management make provisions for the Surface Management Agency, the surface of which is under the jurisdiction of any Federal agency other than the Department of Interior, to consent to leasing and to prescribe conditions to insure the use and protection of the lands. All or part of this lease contains lands the surface of which are managed by the United States Department of Agriculture, Forest Service, Fishlake National Forest.

The following stipulations pertain to the Lessee responsibility for mining operations on the lease area and on adjacent areas as may be specifically designated on National Forest System lands.

5. Before undertaking activities that may disturb the surface of previously undisturbed leased lands, the lessee may be required to conduct a cultural resource inventory and a paleontological appraisal of the areas to be disturbed. These studies shall be conducted by qualified professional cultural resource specialists or qualified paleontologists, as appropriate, and a report prepared itemizing the findings. A plan will then be submitted making recommendations for the protection of, or measures to be taken to mitigate impacts for identified cultural or paleontological resources.

If cultural resources or paleontological remains (fossils) of significant scientific interest are discovered during operations under this lease, the lessee prior to disturbance shall, immediately bring them to the attention of the appropriate authorities. Paleontological remains of significant scientific interest do not include leaves, ferns, or dinosaur tracks commonly encountered during underground mining operations.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

6. If there is reason to believe that Threatened or Endangered (T&E) species of plants or animals, or migratory bird species of high Federal interest occur in the area, the Lessee shall be required to conduct an intensive field inventory of the area to be disturbed and/or impacted. The inventory shall be conducted by a qualified specialist and a report of findings will be prepared. A plan will be prepared making recommendations for the protection of these species or action necessary to mitigate the disturbance.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

7. The Lessee shall be required to perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. Existing data may be used if such data are adequate for the intended purposes. The study shall be adequate to locate, quantify, and demonstrate the interrelationship of the geology, topography, surface and ground water hydrology, vegetation and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison.

8. Powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to provide adequate protection for raptors and other large birds. When feasible, powerlines will be located at least 100 yards from public roads.

9. The limited area available for mine facilities at the coal outcrop, steep topography, adverse winter weather, and physical limitations on the size and design of the access road, are factors which will determine the ultimate size of the surface area utilized for the mine. A site specific environmental analysis will be prepared for each new mine site development and for major modifications to existing developments to examine alternatives and mitigate conflicts.

10. Consideration will be given to site selection to reduce adverse visual impacts. Where alternative sites are available, and each alternative is technically feasible, the alternative involving the least damage to the scenery and other resources shall be selected. Permanent structures and facilities will be designed, and screening techniques employed, to reduce visual impacts, and where possible achieve a final landscape compatible with the natural surroundings. The creation of unusual, objectionable, or unnatural land forms and vegetative landscape features will be avoided.

11. The Lessee shall be required to establish a monitoring system to locate, measure, and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the lease area. The monitoring shall incorporate and be an extension of the baseline data.

12. The lessee shall provide for the suppression and control of fugitive dust on haul roads and at coal handling and storage facilities. On Forest Development Roads (FDR), lessees may perform their share of road maintenance by a commensurate share agreement if a significant degree of traffic is generated that is not related to their activities.

13. Except at specifically approved locations, underground mining operations shall be conducted in such a manner so as to prevent surface subsidence that would: (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides, (2) cause damage to existing surface structures, and (3) damage or alter the flow of perennial streams. The lessee shall provide specific measures for the protection of escarpments, and determine corrective measures to assure that hazardous conditions are not created.

14. In order to avoid surface disturbance on steep canyon slopes and to preclude the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specifically approved locations.

15. If removal of timber is required for clearing of construction sites, etc., such timber shall be removed in accordance with the regulations of the surface management agency.

16. The coal contained within, and authorized for mining under this lease, shall be extracted only by underground mining methods.

17. Existing Forest Service owned or permitted surface improvements will need to be protected, restored, or replaced to provide for the continuance of current land uses.

18. In order to protect big game wintering areas, elk calving and deer fawning areas, sagegrouse strutting areas, and other critical wildlife habitat and/or activities, specific surface uses outside the mine development area may be curtailed during specific periods of the year.

19. Support facilities, structures, equipment, and similar developments will be removed from the lease area within 2 years after the final termination of use of such facilities. This provision shall apply unless the requirement of Section 10 of the lease form is applicable. Disturbed areas and those areas previously occupied by such facilities will be stabilized and rehabilitated, drainages reestablished, and the areas returned to a premining land use.

20. The Lessee at the conclusion of the mining operation, or at other times as surface disturbance related to mining may occur, will replace all damaged, disturbed, or displaced corner monuments (section corners, quarter corners, etc.) their accessories and appendages (witness trees, bearing trees, etc.), or restore them to their original condition and location, or at other locations that meet the requirements of the rectangular surveying system. This work shall be conducted at the expense of the Lessee, by BLM to the standards and guidelines found in the Manual of Surveying Instructions, U.S. Department of Interior.

21. The Lessee, at his expense, will be responsible to replace any surface and/or developed ground water sources identified for protection, that may be lost or adversely affected by mining operations, with water from an alternate source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, livestock and wildlife use, or other land uses (authorized by 36 CFR 251).

22. The Licensee/Permittee/Lessee must comply with all the rules and regulations of the Secretary of Agriculture set forth at Title 36, Chapter II, of the Code of Federal Regulations governing the use and management of the National Forest System (NFS) when not inconsistent with the rights granted by the Secretary of the Interior in the license/permit/lease. The Secretary of Agriculture's rules and regulations must be complied with for (1) all use and occupancy of the NFS prior to approval of a permit/operation plan by the Secretary of Interior, (2) uses of all existing improvements, such as Forest Development Roads, within and outside the area licensed, permitted or leased by the Secretary of Interior, and (3) use and occupancy of the NFS not authorized by a permit/operation plan approved by the Secretary of the Interior.

All matters related to this stipulation are to be addressed to:

Forest Supervisor
Fishlake National Forest
115 East 900 North
Richfield, Utah 84701

Telephone No.: 435-896-9233

who is the authorized representative of the Secretary of Agriculture.

23. Notwithstanding the approval of a resource recovery and protection plan by the BLM, lessor reserves the right to seek damages against the operator/lessee in the event (I) the operator/lessee fails to achieve maximum economic recovery [as defined at 43 CFR §3480.0-5(21)] of the recoverable coal reserves or (ii) the operator/lessee is determined to have caused a wasting of recoverable coal reserves. Damages shall be measured on the basis of the royalty that would have been payable on the wasted or unrecovered coal.

The parties recognize that under an approved R2P2, conditions may require a modification by the operator/lessee of that plan. In the event a coal bed or portion thereof is not to be mined or is rendered unminable by the operation, the operator shall submit appropriate justification to obtain approval by the AO to leave such reserves unmined. Upon approval by the AO, such coal beds or portions thereof shall not be subject to damages as described above. Further, nothing in this section shall prevent the operator/lessee from exercising its right to relinquish all or a portion of the lease as authorized by statute and regulation.

In the event the AO determines that the R2P2 modification will not attain MER resulting from changed conditions, the AO will give proper notice to the operator/lessee as required under applicable regulations. The AO will order a new R2P2 modification if necessary, identifying additional reserves to be mined in order to attain MER. Upon a final administrative or judicial ruling upholding such an ordered modification, any reserves left unmined (wasted) under that plan will be subject to damages as described in the first paragraph under this section.

Subject to the right to appeal hereinafter set forth, payment of the value of the royalty on such unmined recoverable coal reserves shall become due and payable upon determination by the AO that the coal reserves have been rendered unminable or at such time that the lessee has demonstrated an unwillingness to extract the coal.

The BLM may enforce this provision either by issuing a written decision requiring payment of the MMS demand for such royalties, or by issuing a notice of non-compliance. A decision or notice of non-compliance issued by the lessor that payment is due under this stipulation is appealable as allowed by law.

24. WASTE CERTIFICATION: The Lessee shall provide upon abandonment, transfer of operation, assignment of rights, sealing off a mined area and prior to lease relinquishment, certification to the lessor that, based upon a complete search of all the records for the lease and its associated mine operation(s), and upon Lessee's and the operator's knowledge of past mining operations associated with the lease, there has been no reportable quantities of **hazardous substances** per (40 CFR 302.4) or **used oil** [as per Utah State Management Rule R-315-15], discharged, deposited or released within the lease, either on the surface or underground, and that all remedial actions necessary have been taken to protect human health and the environment with respect to any such substances. Lessee must additionally provide to the Lessor a complete list of all hazardous substances and hazardous materials and their Chemical Abstract Registry Numbers, and the oil and petroleum products used or stored on, or delivered to, the lease. Such disclosure will be in addition to any other disclosure required by law or agreement.

25. UNDERGROUND INSPECTION: All safe and accessible areas shall be inspected prior to being sealed. The lessee shall notify the Authorized Officer in writing 30 days prior to the sealing of any areas in the mine and state the reason for closure. Prior to seals being put into place, the lessee shall inspect the area and document any equipment/machinery, hazardous substances, and used oil that is to be left underground. The AO may participate in this inspection.

The purpose of this inspection will be: (1) to provide documentation for compliance with 42 U.S.C. 9620 section 120(h) and Utah State Management Rule R-315-15, and to assure that certification will be meaningful at the time of lease relinquishment, (2) to document the inspection with a mine map showing location of equipment/machinery (model, type of fluid, amount remaining, batteries etc.) that is proposed to be left underground. In addition, these items will be photographed at the Lessee's expense and shall be submitted to the Authorized Officer as part of the certification. The abandonment of any equipment/machinery shall be on a case by case basis and shall not be accomplished unless the Authorized Officer has granted a written approval. Any on-lease disposal of non-coal waste must comply with 30 CFR §817.89.

26. FAIR MARKET VALUE BONUS: Pursuant to 43 CFR 3432.2(c), "the lands applied for shall be added to the existing lease without competitive bidding, but the United States shall receive the fair market value of the lease of the added lands, either by cash payment or adjustment of the royalty applicable to the lands added to the lease by the modification." Therefore, the lessee will pay the fair market value (FMV) bonus payment for the coal resources of the Federal coal lease modification (UTU-47080) Tract 2, in the amount of $155,667, prior to approval of the modification which adds Tract 2 to lease UTU-47080. A payment of $159,334 will be due prior to one year anniversary of the approval of the modification and a final payment of $163,334 will be required to be paid prior to the second year anniversary of the approval of the modification. Finally, an additional bonus payment will be due for the coal resources mined on the areas comprised of Federal coal lease

modification acreage added to coal leases SL- 062583 (Tract 2), UTU-47080 (Tract 2) and UTU-63214 (Tract 3), which exceed 6,930,000 tons mined, at a rate of $.35 per ton for the actual tonnage mined, adjusted annually using the U. S. Bureau of Labor Statistics CPI West Urban Energy Index; or if that index is not available an index that is mutually agreed to by the lessee and the authorized officer will be used. Payment of this part of the FMV at the specified rate and tonnage mined will be on the schedule required for payment of production royalties to the Minerals Management Service (MMS). The lessee will clearly indicate which portion of the payment is for royalty and what is for the lease bonus payment.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Serial No.___UTU-63214_

MODIFIED COAL LEASE

Date of Lease_July 1, 1989___

PART I.

THIS MODIFIED COAL LEASE is entered into on ____________, by and between the **UNITED STATES OF AMERICA**, hereinafter called the Lessor, through the Bureau of Land Management, and
Canyon Fuel Company LLC
c/o Ark Land Company
City Place One, Suite 300
St. Louis, MO 63141

hereinafter called Lessee.

This modified lease shall retain the effective date of July 1, 1989 , of the original **COAL LEASE UTU- 63214**, and is effective for a period of 10 years from the date of the last lease readjustment, dated July 1, 2009 and for so long thereafter as coal is produced in commercial quantities from the leased lands, subject to readjustment of lease terms at the end of each 10 year lease period thereafter.

Sec. 1. This lease is issued pursuant and subject to the terms and provisions of the: (NOTE: Check the appropriate Act or Acts.)

XX Mineral Lands Leasing Act of 1920, as amended, 41 Stat. 437, 30 U.S.C. 181-287, hereinafter referred to as the Act;

_ Mineral Leasing Act for Acquired Lands of 1947, 61 Stat. 913, 30 U.S.C. 351-359;

and to the regulations and formal orders of the Secretary of the Interior which are now or hereafter in force, when not inconsistent with the express and specific provisions herein.

Sec. 2. Lessee as the holder of Coal Lease UTU- 63214, issued effective July 1, 1989 , was granted the exclusive right and privilege to drill for, mine, extract, remove or otherwise process and dispose of the coal deposits in, upon, or under the lands described below as Tract 1 and Tract 2.

The Lessor in consideration of fair market value, rents and royalties to be paid, and the conditions and covenants to be observed as herein set forth, hereby grants and leases to Lessee the exclusive right and privilege to drill for, mine, extract, remove, or otherwise process and dispose of the coal deposits in, upon, or under the lands described below as Tract 3.

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Tract 1:
T. 21 S., R. 4 E., SLM, Utah
Sec. 12, E½SE¼;
Sec. 13, E½NE¼, S½;
Sec. 14, E½SW¼, SE¼;
Sec. 23, E½, E½W½;
Sec. 24, all;

T. 22 S., R. 5 E., SLM, Utah
Sec. 3, lots 1-4, S½N½, NE¼SW¼, S½SW¼, N½SE¼, SW¼SE¼;
Sec. 4, lots 1,2, S½NE¼, SE¼SE¼;
Sec. 9, NE¼NE¼;

T. 21 S. R. 5 E., SLM, Utah
Sec. 15, W½;
Secs. 16-21, all;
Sec. 22, W½;
Sec. 26, W½NW¼SW¼, SW¼SW¼;
Sec. 27, all;
Sec. 28, N½, N½SW¼, SE¼SW¼, SE¼;
Sec. 29, E½NE¼, NE¼SE¼;
Sec. 30, lot 1, N½NE¼;
Sec. 33, lots 2-4, NE¼, E½NW¼, NE¼SW¼, N½SE¼;
Sec. 34, all;

Sec. 10, W½NE¼, NW¼, N½SW¼;

Tract 2:

T. 21 S., R. 5 E., SLM, Utah

Sec. 10, SE¼NW¼, E½SW¼, E½E½SW¼NW¼, E½E½NW¼SW¼, E½E½SW¼SW¼.

Sec. 35, lots 1,2, W½NW¼,N½SW¼.

Tract 3:

T. 21 S., R. 4 E., SLM, Utah

Sec. 26, E½, E½SW¼;

Sec. 35, NW¼, W½SW¼.

containing 10,695.46 acres, more or less, together with the right to construct such works, buildings, plants, structures, equipment and appliances and the right to use such on-lease rights-of-way which may be necessary and convenient in the exercise of the rights and privileges granted, subject to the conditions herein provided.

Part II. TERMS AND CONDITIONS

Sec. 1.(a) RENTAL RATE - Lessee shall pay Lessor rental annually and in advance for each acre or fraction thereof during the continuance of the lease at the rate of $3.00 per acre for each lease year.

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* 20 years (Public Law 109-58)

Sec. 3. BONDS - Lessee shall maintain in the proper office a bond in the amount of $1,600,000 if lands are added to the existing LMU. The authorized officer may require an increase in this amount when additional coverage is determined appropriate.

Sec. 4. DILIGENCE - This lease achieved diligent development February 1, 2003 , and is subject to the conditions of continued operation. Continued operation may be excused when operations under the lease are interrupted by strikes, the elements, or casualties not attributable to the Lessee. The Lessor, in the public interest, may suspend the condition of continued operation upon payment of advance royalties in accordance with the regulations in existence at the time of the suspension.

The Lessor reserves the power to assent to or order the suspension of the terms and conditions of this lease in accordance with, inter alia, Section 39 of the Mineral Leasing Act, 30 U.S.C. 209.

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This lease was placed in the SUFCO LMU effective April 2, 1990.

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Sec. 7. DAMAGES TO PROPERTY AND CONDUCT OF OPERATIONS - Lessee shall comply at its own expense with all reasonable orders of the Secretary, respecting diligent operations, prevention of waste, and protection of other resources.

Lessee shall not conduct exploration operations, other than casual use, without an approved exploration plan. All exploration plans prior to the commencement of mining operations within an approved mining permit area shall be submitted to the authorized officer.

Lessee shall carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health, or property, and prevention of waste, damage or degradation any land, air, water, cultural, biological, visual, and other resources, including mineral deposits and formations of mineral deposits not leased hereunder, and to other land uses or users. Lessee shall take measures deemed necessary by Lessor to accomplish the intent of this lease term. Such measures may include, but not limited to, modification to proposed siting or design of facilities, timing of operations, and specifications of interim and final reclamation procedures. Lessor reserves to itself the right to lease, sell, or otherwise dispose of the surface or other mineral deposits in the lands and the right to continue existing uses and to authorize future uses upon or in the leased lands, including issuing leases for mineral deposits not covered hereunder and approving easements or rights-of-way. Lessor shall condition such uses to prevent unnecessary or unreasonable interference with rights of Lessee as may be consistent with concepts of multiple use and multiple mineral development.

Sec. 8 **PROTECTION OF DIVERSE INTERESTS, AND EQUAL OPPORTUNITY** - Lessee shall: pay when due all taxes legally assessed and levied under the laws of the State or the United States; accord all employees complete freedom of purchase; pay all wages at least twice each month in lawful money of the United States; maintain a safe working environment in accordance with standard industry practices; restrict the workday to not more than 8 hours in any one day for underground workers, except in emergences; and take measures necessary to protect the health and safety of the public. No person under the age of 16 years shall be employed in any mine below the surface. To the extent that laws of the State in which the lands are situated are more restrictive than the provisions in this paragraph, then the State laws apply.

Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor. Neither Lessee nor Lessee's subcontractors shall maintain segregated facilities.

Sec. 9.(a) **TRANSFERS**
(Check the appropriate space)

_X_ This lease may be transferred in whole or in part to any person, association or corporation qualified to hold such lease interest.

__ This lease may be transferred in whole or in part to another public body, or to a person who will mine the coal on behalf of, and for the use of, the public body or to a person who for the limited purpose of creating a security interest in favor of a lender agrees to be obligated to mine the coal on behalf of the public body.

__ This lease may only be transferred in whole or in part to another small business qualified under 13 CFR 121.

Transfers of record title, working or royalty interest <u>must</u> be approved in accordance with the regulations.

(b) **RELINQUISHMENTS** - The Lessee may relinquish in writing at any time all rights under this lease or any portion thereof as provided in the regulations. Upon Lessor's acceptance of the relinquishment, Lessee shall be relieved of all future obligations under the lease or the relinquished portion thereof, whichever is applicable.

Sec. 10. **DELIVERY OF PREMISES, REMOVAL OF MACHINERY, EQUIPMENT, ETC.** - At such times as all portions of this lease are returned to Lessor, Lessee shall deliver up to Lessor the land leased, underground timbering, and such other supports and structures necessary for the preservation of the mine workings on the leased premises or deposits and place all workings in condition for suspension or abandonment. Within 180 days thereof, Lessee shall remove from the premises all other structures, machinery, equipment, tools, and materials that it elects to or as required by the authorized officer. Any such structures, machinery, equipment, tools, and materials remaining on the leased lands beyond 180 days, or approved extension thereof, shall become the property of the Lessor, but Lessee shall either remove any or all such property or shall continue to be liable for the cost of removal and disposal in the amount actually incurred by the Lessor. If the surface is owned by third parties, Lessor shall waive the requirement for removal, provided the third parties do not object to such waiver. Lessee shall, prior to the termination of bond liability or at any other time when required and in accordance with all applicable laws and regulations, reclaim all lands the surface of which has been disturbed, dispose of all debris or solid waste, repair the offsite and onsite damage caused by Lessee's activity or activities incidental thereto, and reclaim access roads or trails.

Sec. 11. **PROCEEDINGS IN CASE OF DEFAULT** - If Lessee fails to comply with applicable laws, existing regulations, or the terms, conditions and stipulations of this lease, and the noncompliance continues for 30 days after written notice thereof, this lease shall be subject to cancellation by the Lessor only by judicial proceedings. This provision shall not be construed to prevent the exercise by Lessor of any other legal and equitable remedy, including waiver of the default. Any such remedy or waiver shall not prevent later cancellation for the same default occurring at any other time.

Sec. 12. **HEIRS AND SUCCESSORS - IN-INTEREST** - Each obligation of this lease shall extend to and be binding upon, and every benefit hereof shall insure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 13. **INDEMNIFICATION** - Lessee shall indemnify and hold harmless the United States from any and all claims arising out of the Lessee's activities and operations under this lease.

Sec. 14. **SPECIAL STATUTES** - This lease is subject to the Federal Water Pollution Control Act (33 U.S.C. 1151 - 1175); the Clean Air Act (42 U.S.C. 1857 et seq.), and to all other applicable laws pertaining to exploration activities, mining operations and reclamation, including the Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et seq.)

Sec. 15. **SPECIAL STIPULATIONS** -

SEE ATTACHED STIPULATIONS

The United States of America

Canyon Fuel Company, LLC

Company or Lessee Name

BY Roger L. Bankert

Roger L Bankert

(Signing Officer)

(Signature of Lessee)

President

(Title)

Chief, Branch of Minerals

(Title)

11/10/09

(Date)

11/23/09

(Date)

Title 18 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

SPECIAL STIPULATIONS FOR UTU-63214
MODIFIED COAL LEASE

1. Before undertaking activities that may disturb the surface of previously undisturbed leased lands, the lessee may be required to conduct a cultural resource inventory and a paleontological appraisal of the areas to be disturbed. These studies shall be conducted by qualified professional cultural resource specialists or qualified paleontologists, as appropriate, and a report prepared itemizing the findings. A plan will then be submitted making recommendations for the protection of, or measures to be taken to mitigate impacts for identified cultural or paleontological resources.

If cultural resources or paleontological remains (fossils) of significant scientific interest are discovered during operations under this lease, the lessee prior to disturbance shall, immediately bring them to the attention of the appropriate authorities. Paleontological remains of significant scientific interest do not include leaves, ferns, or dinosaur tracks commonly encountered during underground mining operations.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

2. If there is reason to believe that Threatened or Endangered (T&E) species of plants or animals, or migratory bird species of high Federal interest occur in the area, the Lessee shall be required to conduct an intensive field inventory of the area to be disturbed and/or impacted. The inventory shall be conducted by a qualified specialist and a report of findings will be prepared. A plan will be prepared making recommendations for the protection of these species or action necessary to mitigate the disturbance.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

3. The Lessee shall be required to perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. Existing data may be used if such data are adequate for the intended purposes. The study shall be adequate to locate, quantify, and demonstrate the interrelationship of the geology, topography, surface and ground water hydrology, vegetation and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison.

4. Powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to provide adequate protection for raptors and other large birds. When feasible, powerlines will be located at least 100 yards from public roads.

5. The limited area available for mine facilities at the coal outcrop, steep topography, adverse winter weather, and physical limitations on the size and design of the access road, are factors which will determine the ultimate size of the surface area utilized for the mine. A site specific environmental analysis will be prepared for each new mine site development and for major modifications to existing developments to examine alternatives and mitigate conflicts.

6. Consideration will be given to site selection to reduce adverse visual impacts. Where alternative sites are available, and each alternative is technically feasible, the alternative involving the least damage to the scenery and other resources shall be selected. Permanent structures and facilities will be designed, and screening techniques employed, to reduce visual impacts, and where possible achieve a final landscape

compatible with the natural surroundings. The creation of unusual, objectionable, or unnatural land forms and vegetative landscape features will be avoided.

7. The lessee shall be required to establish a monitoring system to locate, measure, and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the lease area. The monitoring shall incorporate and be an extension of the baseline data.

8. The lessee shall provide for the suppression and control of fugitive dust on haul roads and at coal handling and storage facilities. On Forest Development Roads (FDR), lessees may perform their share of road maintenance by a commensurate share agreement if a significant degree of traffic is generated that is not related to their activities.

9. Except at locations specifically approved by the Authorized Officer, with concurrence of the Forest Service, underground mining operations shall be conducted in such a manner so as to prevent surface subsidence that would: (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides, (2) cause damage to existing surface structures, and (3) damage or alter the flow of perennial streams. The lessee shall provide specific measures for the protection of escarpments, and determine corrective measures to assure that hazardous conditions are not created.

10. In order to avoid surface disturbance on steep canyon slopes and to preclude the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specifically approved locations.

11. If removal of timber is required for clearing of construction sites, etc., such timber shall be removed in accordance with the regulations of the surface management agency.

12. The coal contained within, and authorized for mining under this lease, shall be extracted only by underground mining methods.

13. Existing Forest Service owned or permitted surface improvements will need to be protected, restored, or replaced to provide for the continuance of current land uses.

14. In order to protect big game wintering areas, elk calving and deer fawning areas, sagegrouse strutting areas, and other critical wildlife habitat and/or activities, specific surface uses outside the mine development area may be curtailed during specific periods of the year.

15. Support facilities, structures, equipment, and similar developments will be removed from the lease area within 2 years after the final termination of use of such facilities. This provision shall apply unless the requirement of Section 10 of the lease form is applicable. Disturbed areas and those areas previously occupied by such facilities will be stabilized and rehabilitated, drainages reestablished, and the areas returned to an acceptable post mining land use.

16. The Lessee at the conclusion of the mining operation, or at other times as surface disturbance related to mining may occur, will replace all damaged, disturbed, or displaced corner monuments (section corners, quarter corners, etc.) their accessories and appendages (witness trees, bearing trees, etc.), or restore them to their original condition and location, or at other locations that meet the requirements of the rectangular surveying system. This work shall be conducted at the expense of the Lessee, by BLM, to the standards and guidelines found in the Manual of Surveying Instructions, U.S. Department of Interior.

17. The Lessee, at his expense, will be responsible to replace any surface and/or developed ground water sources identified for protection, that may be lost or adversely affected by mining operations, with water from an alternate source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, livestock and wildlife use, or other land uses (authorized by 36 CFR 251).

18. The Licensee/Permittee/Lessee must comply with all the rules and regulations of the Secretary of Agriculture set forth at Title 36, Chapter II, of the Code of Federal Regulations governing the use and management of the National Forest System (NFS) when not inconsistent with the rights granted by the Secretary of the Interior in the license/permit/lease. The Secretary of Agriculture's rules and regulations must be complied with for (1) all use and occupancy of the NFS prior to approval of a permit/operation plan by the Secretary of Interior, (2) uses of all existing improvements, such as Forest Development Roads, within and outside the area licensed, permitted or leased by the Secretary of Interior, and (3) use and occupancy of the NFS not authorized by a permit/operation plan approved by the Secretary of the Interior.

All matters related to this stipulation are to be addressed to:

Forest Supervisor
Fishlake National Forest
115 East 900 North
Richfield, Utah 84701

Telephone No.: 435-896-9233

who is the authorized representative of the Secretary of Agriculture.

19. Notwithstanding the approval of a resource recovery and protection plan by the BLM, lessor reserves the right to seek damages against the operator/lessee in the event (I) the operator/lessee fails to achieve maximum economic recovery [as defined at 43 CFR §3480.0-5(21)] of the recoverable coal reserves or (ii) the operator/lessee is determined to have caused a wasting of recoverable coal reserves. Damages shall be measured on the basis of the royalty that would have been payable on the wasted or unrecovered coal.

The parties recognize that under an approved R2P2, conditions may require a modification by the operator/lessee of that plan. In the event a coal bed or portion thereof is not to be mined or is rendered unminable by the operation, the operator shall submit appropriate justification to obtain approval by the AO to leave such reserves unmined. Upon approval by the AO, such coal beds or portions thereof shall not be subject to damages as described above. Further, nothing in this section shall prevent the operator/lessee from exercising its right to relinquish all or a portion of the lease as authorized by statute and regulation.

In the event the AO determines that the R2P2 modification will not attain MER resulting from changed conditions, the AO will give proper notice to the operator/lessee as required under applicable regulations. The AO will order a new R2P2 modification if necessary, identifying additional reserves to be mined in order to attain MER. Upon a final administrative or judicial ruling upholding such an ordered modification, any reserves left unmined (wasted) under that plan will be subject to damages as described in the first paragraph under this section.

Subject to the right to appeal hereinafter set forth, payment of the value of the royalty on such unmined recoverable coal reserves shall become due and payable upon determination by the AO that the coal reserves have been rendered unminable or at such time that the lessee has demonstrated an unwillingness to extract the coal.

The BLM may enforce this provision either by issuing a written decision requiring payment of the MMS demand for such royalties, or by issuing a notice of non-compliance. A decision or notice of non-compliance issued by the lessor that payment is due under this stipulation is appealable as allowed by law.

20. WASTE CERTIFICATION: The lessee shall provide upon abandonment and/or sealing off a mined area and prior to lease termination/relinquishment, certification to the lessor that, based upon a complete search of all the operator's records for the mine and upon their knowledge of past operations, there has been no **hazardous substances** per (40 CFR 302.4) or **used oil** as per Utah State Management Rule R-315-15, deposited within the lease, either on the surface or underground, or that all remedial action necessary has been taken to protect human health and the environment with respect to any such substances remaining on the property. The back-up documentation to be provided shall be described by the lessor prior to the first certification and shall include all documentation applicable to the Emergency Planning and Community Right-to-know Act (EPCRA, Public Law 99-499), Title III of the Superfund Amendments and Reauthorization Act of 1986 or equivalent.

21. ABANDONMENT OF EQUIPMENT: The lessee/operator is responsible for compliance with reporting regarding toxic and hazardous material and substances under Federal Law and all associated amendments and regulations for the handling such materials on the land surface and in underground mine workings.

The lessee/operator must remove mine equipment and materials not needed for continued operations, roof support and mine safety from underground workings prior to abandonment of mine sections. Exceptions can be approved by the Authorized Officer (BLM) in consultation with the surface management agency. Creation of a situation that would prevent removal of such material and by retreat or abandonment of mine sections without prior authorization would be considered noncompliance with lease terms and conditions and subject to appropriate penalties under the lease.

22. UNDERGROUND INSPECTION: All safe and accessible areas shall be inspected prior to being sealed. The lessee shall notify the Authorized Officer in writing 30 days prior to the sealing of any areas in the mine and state the reason for closure. Prior to seals being put into place, the lessee shall inspect the area and document any equipment/machinery, hazardous substances, and used oil that is to be left underground.

The purpose of this inspection will be: (1) to provide documentation for compliance with 42 U.S.C. 9620 section 120(h) and State Management Rule R-315-15, and to assure that certification will be meaningful at the time of lease relinquishment, (2) to document the inspection with a mine map showing location of equipment/machinery (model, type of fluid, amount remaining, batteries etc.) that is proposed to be left underground. In addition, these items will be photographed at the lessee's expense and shall be submitted to the Authorized Officer as part of the certification. The abandonment of any equipment/machinery shall be on a case by case basis and shall not be accomplished unless the Authorized Officer has granted a written approval.

23. GOB VENT BOREHOLES. The Lessee shall submit a gob vent borehole plan for approval by the AO as part of an R2P2 for all gob vent boreholes. The plugging portion of the plan must meet 43 CFR 3484.1(a)(3) as a minimum. If variations to the approved plugging procedures are necessary, they shall also be approved by the AO in writing prior to implementation of the procedures.

24. FAIR MARKET VALUE BONUS: Pursuant to 43 CFR 3432.2(c), "the lands applied for shall be added to the existing lease without competitive bidding, but the United States shall receive the fair market value of the lease of the added lands, either by cash payment or adjustment of the royalty applicable to the lands added to the lease by the modification." Therefore, the lessee will pay the fair market value (FMV) bonus payment for the coal resources mined in the area of Federal coal lease modification (UTU-63214) Tract 2: Due to the uncertainty of the amount of recoverable coal tons in this modification and the uncertainty in mining conditions, the lessee will pay the fair market value (FMV) for the coal resources mined in the area of Federal Coal Lease Modification (UTU-63214 Tract 2) at the rate of $0.25 per ton for the actual tonnage mined. Payment of the FMV at the specified rate and tonnage mined will be on the schedule required for payment of production royalties to the Minerals Management Service (MMS). The lessee will clearly indicate which portion of the payment is for royalty and what is for lease bonus payment. Tract 3: in the amount of $155,666, prior to approval of the modification adding Tract 3 to lease UTU-63214. A payment of $159,333 will be due prior to one year anniversary of the approval of the modification and a final payment of $163,333 will be required to be paid prior to the second year anniversary of the approval of the modification. Finally, an additional bonus payment will be due for the coal resources mined on the areas comprised of Federal coal lease modification acreage added to coal leases SL- 062583 (Tract 2), UTU-47080 (Tract 2) and UTU-63214

(Tract 3), which exceed 6,930,000 tons mined, at a rate of $.35 per ton for the actual tonnage mined, adjusted annually using the U. S. Bureau of Labor Statistics CPI West Urban Energy Index; or if that index is not available, an index that is mutually agreed to by the lessee and the authorized officer will be used. Payment of this part of the FMV at the specified rate and tonnage mined will be on the schedule required for payment of production royalties to the Minerals Management Service (MMS). The lessee will clearly indicate which portion of the payment is for royalty and what is for the lease bonus payment.

APPENDIX 3-13

Vegetation and Wildlife of the West Coal Lease Modifications

United States Department of the Interior
Bureau of Land Management

Environmental Assessment UT-070-08-083
January 2009

Project Title:
West Coal Lease Modifications Environmental Assessment, Sevier County, Utah

Location:	***Sevier County, Utah***
Applicant/Address:	**Ark Land Company** **1 City Place Drive, Suite 300** **St. Louis, Missouri 63141**

Lead Agency:

U.S. Department of the Interior
Bureau of Land Management
Price Field Office
125 South 600 West
Price, Utah 84501
Phone: 435-636-3600
FAX: 435-636-3657

Cooperating Agencies:

Fishlake National Forest
Richfield, Utah

U.S. Department of Interior
Office of Surface Mining
Denver, Colorado

BLM

West Coal Lease Modifications Environmental Assessment
UT-070-08-083

Contents

Page

List of Tables

List of Figures

West Coal Lease Modifications Environmental Assessment UT-070-08-083

1.0 PURPOSE and NEED

1.1 Introduction

This Environmental Assessment (EA) has been prepared to analyze and disclose the environmental consequences of three proposed coal lease modifications (West Coal Lease Modifications) requested by Ark Land Company (Ark). These lease modifications, and the subsequent underground, longwall extraction of coal on the modified leases, constitute the proposed action addressed in this EA.

This EA documents site-specific analysis of the potential impacts of implementing the proposed action or alternatives to the proposed action. The EA assists the Bureau of Land Management (BLM) and Forest Service in project planning and in ensuring compliance with the National Environmental Policy Act (NEPA), particularly in making a determination as to whether any "significant" impacts could result from the actions addressed.

Significance is defined by NEPA (40 CFR 1508.27). If the agency decision maker determined that this project would have significant impacts based on the analysis in the EA, then an Environmental Impact Statement (EIS) would be prepared for the project. If not, a "Finding of No Significant Impact" (FONSI) would be prepared and released with a Decision Record (DR) approving the selected alternative, whether the proposed action or another alternative. The DR would document the reasons why implementation of the selected alternative would not result in significant environmental effects.

The surface and coal resources associated with these lease modifications are both federally controlled. The BLM administers the subsurface coal resources through their State Office. The Fishlake National Forest administers the surface resources. Because the proposed action involves no surface development, the BLM is the lead agency in this process, and the Forest Service is a cooperating agency.

The BLM's decision is whether, and under what terms and conditions, to lease the tracts. The Forest Service's role is consultative, in accordance with BLM regulations regarding coal lease modifications (43 CFR 3432[3][d]), particularly protection of non-mineral natural resources managed by the Forest Service. The proposed lease modifications are consistent with the application, terms and conditions stated in these regulations, including the size of the modifications, interest of the U.S., absence of competitive interests, and lack of another independent interest to develop the leases.

1.2 Background

Ark has filed an application for modification of three existing, contiguous, Federal coal leases located approximately 12 miles north and northwest of Emery, Utah, on the Fishlake National Forest (see Figure 1-1). Specifically, a previous Ark application for modification of leases SL-062583 and U-47080 was revised following discussion of the original application with the BLM to include modification of lease UTU-63214, the Quitchupah Tract.

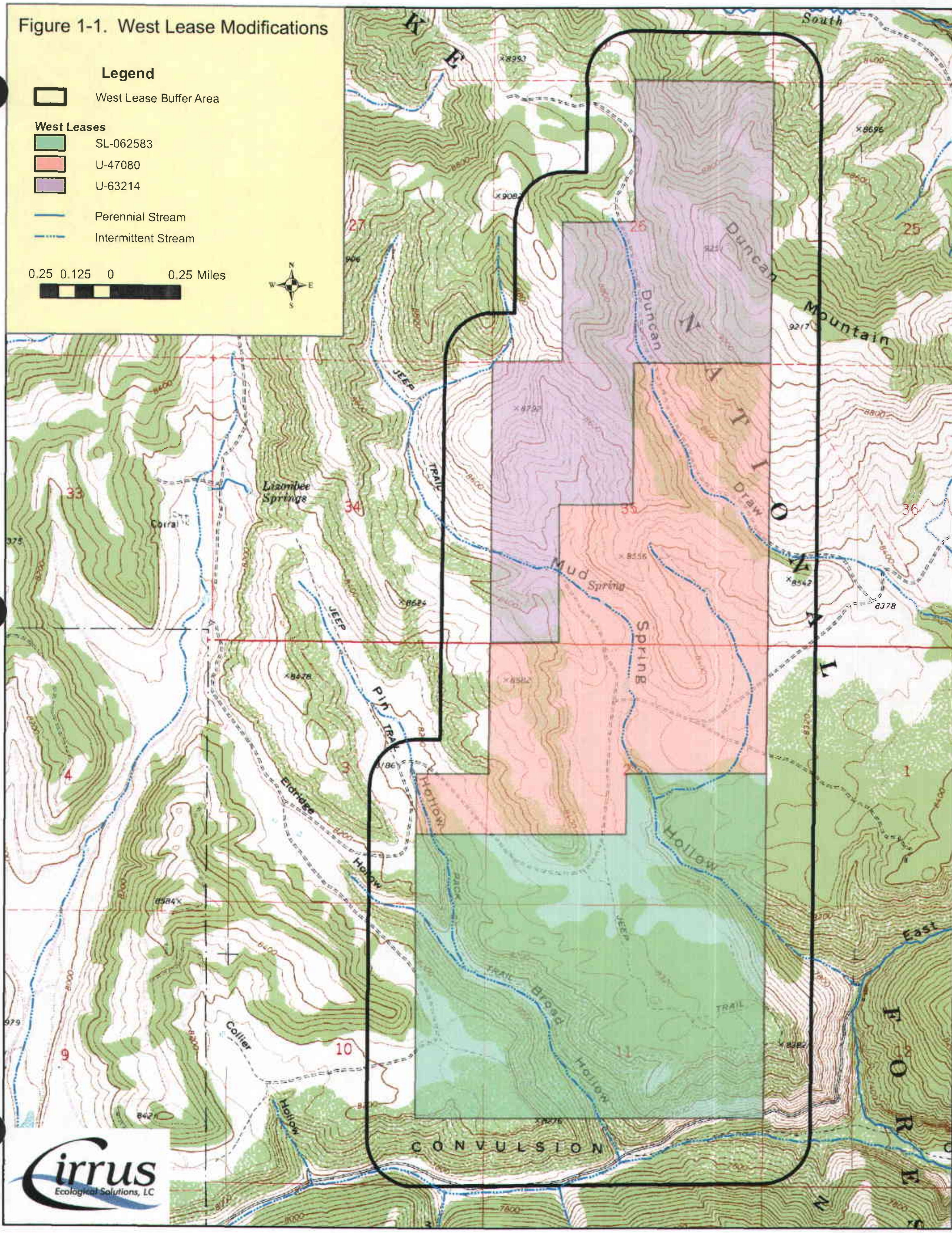


Figure 1-1. West Lease Modifications

Ark desires to add approximately 2,316 total surface acres to the three leases by extending them westward. This would increase the coal reserves to be recovered using underground mining methods by SUFCO Mine, operated by Ark subsidiary Canyon Fuel. No additional surface infrastructure would be required on areas covered by the proposed lease modifications.

1.3 Need for the Proposed Action

Ark, as holder of the existing leases, has applied for the proposed lease modifications to gain access to additional recoverable coal for SUFCO Mine. Without additional leases, coal reserves would be exhausted in the near future. Therefore, the need expressed by Ark's application is to extend the viable life of SUFCO Mine, maintain production, remain competitive in the current coal market, and meet current coal contracts. Efficiencies would be achieved, and impacts reduced, by using the existing SUFCO Mine infrastructure to recover the additional coal.

Recoverable coal resources on these leases are estimated at 23.1 million tons. SUFCO Mine currently produces about 7 million tons per year. At that rate, the proposed lease modifications would extend the life of the mine by about 3 years, supplying the household electrical energy needs for some 3.5 million citizens over that period. However, other lease options are investigated and pursued on an ongoing basis (see section 4.3, Cumulative Impacts, below) so full extraction of this coal would likely take more than 3 years.

Coal on these leases would likely not be mined by any entity other than SUFCO Mine due to the area's geographical and geological isolation, making it bypassed coal.

1.4 Purposes of the Proposed Action

The BLM is considering Ark's requested lease modification because the activity is an integral part of BLM's coal leasing program under authority of the Mineral Leasing Act of 1920, as amended by the Federal Coal Leasing Amendments Act of 1976 (FCLAA) and supplemented in 1978. Coal development is recognized as an appropriate use of public lands within the Wasatch Plateau Coal Field.

The BLM will consider approval of the proposed lease modification in a manner that avoids or reduces impact on resources and activities, is consistent with the lease rights granted to the applicant, and prevents unnecessary or undue degradation of the public lands.

The Forest Service is considering the proposed lease modifications because they would provide appropriate opportunities for leasing and development of recoverable coal resources and make cleared tracts available for leasing, subject to the mitigating requirements determined through multiple-use management and environmental impact assessment (Forest Service 1986).

As noted above, coal in the expanded lease areas would likely be by-passed in the absence of this proposed action, and thus not serve the interests of the people of the U.S. Use of existing SUFCO Mine infrastructure would allow its recovery most efficiently, without additional surface development and associated environmental impacts.

1.5 Conformance with Agency Land Use Plans

There is no BLM land use plan that is relevant to the proposed lease modifications, as the surface land and resources are under Forest Service management. The applicable Forest Service land use plan is the *Fishlake National Forest Land and Resource Management Plan* (1986; Forest Plan). The Forest Service completed a Forest Plan Consistency analysis documented in a letter to the

BLM State Director (Forest Service 2008). In brief, the conclusions of that analysis are as follows:

- The lands involved in these modifications are within areas 75 and 82 (Forest Plan, Appendix O, p. 0-8), which are designated as Class IV and Class I-IV, respectively, indicating favorable potential for coal reserves.

- The three lease modifications lie within 4B and 6B Management Areas addressed in the Forest Plan. Coal lease SL-062583 is in Management Area 6B where intensive grazing management systems are favored over extensive ones, and other management emphases include but are not limited to recreation, silviculture, wildlife, and visual resources. Leases U-47080 and UTU-63214 are in Management Area 4B, where the management emphasis is on the habitat needs of one or more management indicator species.

- In general, coal leasing would be compatible with prescriptions for these two Management Areas due to the fact that underground mining methods and the absence of surface infrastructure would avoid surface disturbance which could impact the surface resources of concern. This conclusion is subject to further analysis as documented in this EA.

1.6 Relationship to Statutes, Regulations, or other Plans

As discussed above under Purposes of the Proposed Action, these lease modifications would be consistent with the Mineral Leasing Act of 1920, amended by the FCLAA as well as 1978 supplements. Further, the FLCAA directs that "no lease sale shall be held unless the lands containing coal deposits have been included in a comprehensive land use plan and such sale is compatible with such plan." As noted in the preceding section on Conformance with Agency Land Use Plans, these applications are consistent with the Forest Plan.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) requires a review of potential lease areas for suitability for certain types of coal mining. Since these three areas are part of the Wasatch Plateau Coal Field, in the Wasatch Plateau Known Recoverable Coal Resource Area, they have already been determined to be suitable for the proposed type of mining.

In regard to other relevant NEPA documents, existing lease SL-062583 has an effective date of September 11, 1941. Lease U-47080 is dated October 1, 1981, and UTU-63214 is dated July 1, 1989. The environmental effects of the earliest lease were not subject to NEPA analysis as it was issued before the law was passed. However, this lease was restructured in 2000 and subjected to NEPA review. The other two leases were addressed in an untitled environmental assessment for coal lease application U-47080 (Forest Service 1981) and *Environmental Assessment for Coastal States Energy Company Coal Lease Application U-63214* (Forest Service and BLM 1988). These NEPA documents are incorporated by reference.

In addition to the key Federal regulations discussed above, additional Federal, State, and local permits and authorizations may be required. Table 1-1 summarizes these.

Table 1-1. Other Federal, State, and local permits, authorizations, or consultations.

Agency	Type of Action	Description of Permit or Activity
Federal		
Office of Surface Mining	Surface Mining Control and Reclamation Act of 1977 (SMCRA) compliance and oversight of cooperative agreement with State of Utah.	Issue Federal Mine Plan Approval if major modification requires it.
Fish and Wildlife Service	Section 7 Consultation	Biological Opinion or concurrence letter required for actions by Federal agencies that could affect species listed under the Endangered Species Act.
Army Corps of Engineers	Section 404 Permitting	Permit required for the discharge of dredged or fill material into waters of the U.S., including wetlands, as required under the Clean Water Act, if necessary.
State		
Division of Oil, Gas, and Mining	Participation in Cooperative Agreement for SMCRA.	Mining and Reclamation Permit for any disturbed area, if necessary.
State Historic Preservation Office	Section 106 Consultations	Concurrence letter required for agency actions that could affect heritage resources protected under the National Historic Preservation Act.
Division of Air Quality	Clean Air Act compliance.	Updated air quality permitting if increased mining levels exceed current permits.
Division of Water Quality	Clean Water Act compliance.	Updated mine discharge permit if necessary.

1.7 Identification of Issues

Issues to be addressed in this EA were identified in two ways, through a scoping exercise inviting comment from the public and from other agencies, and through standard, internal, interdisciplinary review of the proposal. Both are described in detail (see section 5.3, Summary of Public Participation).

A scoping report, including the legal notice, the comment letter, and a discussion of how each comment affects the scope of the analysis was prepared and included in the project record.

The results of the internal review are documented in the BLM's standard Interdisciplinary Team Analysis Record Checklist, which is attached as Appendix A. The review included consideration of the Critical Elements of the Human Environment. These elements are specified in statute, regulation, or executive order, and must be considered in all EAs.

The internal review covered all substantive issues raised by scoping comments. The checklist identified the resource areas with the potential for significant impact, warranting detailed analysis in this EA. The four resource areas addressed through detailed analysis are listed below and described in detail in section 3.3, Resources/Issues Brought Forward for Analysis.

- Surface and Ground Water. (As the project area is not part of any municipal watershed, potential drinking water impacts are not a concern.)

- Wetlands.

- Terrestrial and Aquatic Wildlife Resources. (No federally listed or candidate plant or wildlife species, or their critical habitats, have been identified in the project area.)

- Heritage Resources.

1.8 Summary

This chapter has introduced and presented the purpose and need for the proposed action, as well as the relevant issues – i.e., those elements of the human environment that could be affected by the implementation of the proposed action. The proposed action and the NEPA-mandated no-action alternative are described in Chapter 2, which concludes with a summary and comparison their environmental effects. The affected environment as it relates to the relevant environmental issues is described in Chapter 3, setting the stage for discussion of the potential environmental impacts or consequences resulting from the implementation of each alternative in Chapter 4. Chapter 5 outlines consultation and coordination efforts carried out through this NEPA process, and Chapter 6 provides references cited in the text of the EA and other supporting information.

2.0 DESCRIPTION OF ALTERNATIVES, INCLUDING PROPOSED ACTION

2.1 Introduction

Under NEPA, an EA should identify and analyze alternatives to a proposed action that avoid or reduce impacts of the proposed action while still addressing the stated purpose and need for it. In this instance, no alternative-driving impacts associated with the proposed action were identified. NEPA also requires that an EA address a no-action alternative – e.g., the scenario that would occur if the proposed action or an action alternative were not implemented – to provide a baseline for impact assessment (40 CFR 1502.14[d]). As a result, the range of alternatives addressed in this EA is the Alternative A, the proposed action, and the no-action alternative, Alternative B.

As discussed in detail above (sections 1.3 and 1.4), the need addressed by Ark's proposal is to extend the viable life of SUFCO Mine, maintain production, remain competitive in the current coal market, and to meet current coal contracts. The BLM's purposes are to address the objectives of the BLM's coal leasing program under authority of the Mineral Leasing Act of 1920 as amended, in a manner that avoids or reduces impact on resources and activities, is consistent with the lease rights granted to the applicant, and prevents unnecessary or undue degradation of the public lands.

The Forest Service is considering the proposed lease modifications because they would provide appropriate opportunities for leasing and development of recoverable coal resources and consent to making cleared tracts available for leasing, subject to the mitigating requirements determined through multiple-use management and environmental impact assessment.

By definition, the no-action alternative does not address the purpose and need of the proposed action. It is included in the analysis as a point of reference for impact assessment. Therefore, the scope of this EA is to assess the effects of the proposed action on the four resource areas described above (section 1.7), using the no-action scenario as a baseline for comparison. The results of this analysis are summarized in the last section of this chapter.

2.2 Alternative A – Proposed Action

Ark has requested approval to modify three existing Federal coal leases located approximately 12 miles north and northwest of Emery, Utah, on the Fishlake National Forest (see Figure 1-1). Ark has filed application to add approximately 2,316 total acres to the three leases. Approximately 880 acres would be added to the 2,199.83-acre SL-062583 lease, 796 acres to the 1,158.05-acre U-47080 lease, and 640 acres to the 10,055.46-acre UTU-63214 lease.

The proposed modification of these federal coal leases involves adding coal reserves to be recovered using underground mining methods. This would occur through extension of the existing SUFCO Mine, using in-place infrastructure and resulting in no surface development on the modification areas. A new portal may be required, but it would be located on the existing leases and be dealt with from a permitting perspective as a change to the existing mine plan. Thus the new portal is not part of this proposed action.

Similarly, Ark may request authorization for coal exploration (e.g., drilling or other methods) on the modification areas if a lease is issued. This would entail development and submittal of an exploration plan which would then be subject to NEPA review prior to approval. As a result, potential exploration is not part of this proposed action.

Mining of the lease modification areas would be regulated according to the same terms and conditions specified by the BLM and stipulations mandated by the Forest Service under the existing leases unless analysis indicates a need for change. The BLM terms and conditions include a general provision to prevent "damage or degradation to any land, air, water, heritage, biological, visual, and other resources…" The Forest Service stipulations provide detailed measures to avoid adverse effects on a broad range of National Forest System resources on or adjacent to leased lands. Current stipulations are attached as Appendix B.

These stipulations may be revised as appropriate based on the analysis documented in this EA. It should also be noted that the stipulations are considered in this assessment of environmental effects but are actually implemented at other phases of the permitting process and actual mining. For example, stipulation no. 9 calls for mining to be conducted in a manner that prevents subsidence that would damage or alter the flow of perennial streams. If such impacts were projected in this EA, the review of the permittee's mining plan would address this potential impact and might call for mine plan revision so no gate roads were developed under the stream.

2.3 Alternative B – No Action

Under the no-action alternative, Ark's application would be denied, precluding expansion of SUFCO Mine's operations onto the proposed lease modification areas. Ark would continue to explore other means to extend the viable life of SUFCO Mine, maintain production, remain competitive in the current coal market, and to meet current coal contracts.

The three lease modifications lie within 4B and 6B Management Areas addressed in the Forest Plan. Coal lease SL-062583 is in Management Area 6B where intensive grazing management systems are favored over extensive ones, and other management emphases include but are not limited to recreation, silviculture, wildlife, and visual resources. Leases U-47080 and UTU-63214 are in Management Area 4B, where the management emphasis is on the habitat needs of one or more management indicator species. Management of these areas would continue focus on these objectives, in accordance with applicable Forest Plan standards, guidelines, and other management direction.

2.4 Alternatives Considered but Eliminated from Further Analysis

As discussed above under Background (section 1.2), Ark's original application requested modification of two of the subject leases, SL-062583 and U-47080, but following discussion with the BLM the application was revised to include lease UTU-63214, the Quitchupah Tract. This revision was viewed as more responsive to the underlying purpose and need. Since no notable environmental impacts due to adding the third lease have been identified, the original application for two modifications was not considered as an alternative warranting detailed analysis.

Also, as noted above under Introduction (section 1.1), there are no competitive interests in these coal reserves and, absent SUFCO Mine's proximity and in-place infrastructure, these reserves would be by-passed. As a result, leasing to another potential applicant was not considered a viable alternative.

Beyond that, as noted above (section 2.1), no alternative-driving impacts have been identified through this analysis. No reconfiguration of the lease modifications or alteration of the mining method would avoid or substantially reduce the impacts disclosed in this EA.

2.5 Summary Comparison of Environmental Impacts

Table 2-1 summarizes and compares the impacts associated with the proposed action and no-action alternatives.

Table 2-1. Summary comparison of the effects of the no-action alternative and the proposed action.

Resource Area	A – Proposed Action	B – No Action
Surface and Ground Water	Longwall mining activities result in subsidence-induced ground movements and other changes in geology, topography, and hydrology. Changes in surface slopes resulting from differential subsidence would be generally less than 1 to 2 percent at most overburden cover depths in the modification areas, and vertical subsidence would likely not be visually discernable. Changes in channel gradient may become more abrupt near the south end of the project area where overburden depths are shallower and the subsidence factor is greater. Since channel gradients are greater here, any change would be indistinguishable. Permanent loss of surface water to underground mine workings would be unlikely in most of the project area. The probability of surface tensile fractures affecting springs, seeps, and stock ponds located in the northern portion of the lease area is low. Any short-term loss of flow in intermittent channels would enhance the rate of subsurface flow downstream of the point of loss and would eventually resurface in lower channel segments. Springs and seeps in Pin Hollow and lower Mud Springs Hollow are more susceptible to development of surface or shallow subsurface tensile fractures, particularly if boundaries of gate roads and longwall panels were located in the area. Sandstone material at these locations would increase the risk and extend the amount of time needed to heal cracks. Water could be diverted to a downslope location. In terms of stock water, the spring/seep used to fill the trough in Pin Hollow and spring/seep in lower Mud Spring Hollow could potentially be affected in the long term or permanently. Mitigation would require replacement of lost water. No transbasin diversions would occur, and water conveying faults are not expected to be encountered. The quality of mine water discharge or mine water that accumulates in mined out areas would be similar to the quality of ground water in the overlying geology and to the current SUFCO mine discharge.	Under this alternative, the identified direct, indirect, and cumulative impacts on surface and ground water due to the proposed action would not occur. These resources would continue to be subject primarily to the forces of nature (e.g., climatic variation and earthquakes).

Table 2-1. (cont'd) Summary comparison of the effects of the no-action alternative and the proposed action.		
Resource Area	**A – Proposed Action**	**B – No Action**
Wetlands	Potential impacts on wetlands would be indirect, caused by changes in hydrology due to mining-induced subsidence, as summarized above. Most drainages in the modification areas support limited areas of wetlands which could potentially be affected by surface tensile cracks. In the northern portion of the lease area, the potential for impacts is low, and any effect would likely be temporary. Two springs in the southern portion could be affected by permanent surface or subsurface tensile cracks, resulting in a contraction or loss of wetlands. If temporary changes in hydrology occurred and climatic conditions were not too severe, wetland vegetation would likely persist and recover when the hydrology returned. If water were permanently diverted to a new, downslope location, a corresponding loss of wetlands would occur, but wetlands would likely develop at the new downstream location over time.	Under this alternative, the identified direct, indirect, and cumulative impacts on wetlands and mesic meadows due to the proposed action would not occur. These resources would continue to be subject primarily to the forces of nature (e.g., climatic variation) and ongoing grazing with its associated trampling and herbivory of wetland plants.
Terrestrial and Aquatic Wildlife	Individuals of three Forest Service Region 4 sensitive species (spotted bat, Townsends big-eared bat, and greater sage-grouse) could be adversely affected by the proposed action. These effects could involve individuals but would not affect population viability or contribute to a trend toward federal listing. Several Management Indicator Species, including riparian nesting birds and aquatic macroinvertebrates, could be adversely affected by the proposed action. The scope and magnitude of potential adverse effects is low due to (1) the limited extent, spotty distribution, and relatively low quality of the riparian and aquatic habitat present in the modification areas, and (2) the self-correcting nature of impacts on the hydrology supporting riparian and aquatic habitats discussed above. Forest-wide populations and trends would not be affected. The Southern Rockies/Colorado Plateau supports 29 migratory bird species of, a number of which could occur in the modification areas. Those that nest in riparian habitats could be adversely affected due to potential reduction in riparian nesting habitats, but the scope and magnitude of potential adverse effects is low due to the limited extent, spotty distribution, and relatively low quality of the riparian and aquatic habitat present and to the self-correcting nature of hyrologic impacts on habitat. Subsidence-induced failure of escarpments could effect cliff-nesting species, but nesting sites are generally not limiting and new habitat would be created to offset any loss. Overall, the proposed action should have no notable, adverse impact on migratory birds.	Under this alternative, the identified direct, indirect, and cumulative impacts on terrestrial and aquatic wildlife due to the proposed action would not occur. These resources would continue to be subject primarily to the forces of nature (e.g., climatic variation) and ongoing grazing with its associated impacts on upland and aquatic habitats.

Table 2-1. (cont'd) Summary comparison of the effects of the no-action alternative and the proposed action.

Resource Area	A – Proposed Action	B – No Action
Heritage Resources	If the proposed action were pursued, then subsidence associated with the subsurface mining could impact six prehistoric rock shelters with associated artifacts and/or rock art. However, Forest Service lease stipulation no. 1 (see Appendix B) would be in force to prevent or mitigate these potential impacts as well as impacts on other heritage or paleontological resources discovered during future mining operations.	Under this alternative, the identified direct, indirect, and cumulative impacts on heritage resources due to the proposed action would not occur. These resources would continue to be subject primarily to the forces of nature (e.g., floods and earthquakes) and ongoing recreational use with its associated potential for looting or inadvertent damage.

3.0 AFFECTED ENVIRONMENT

3.1 Introduction

This chapter describes the potentially affected existing environment of the project area in terms of the four issues carried into detailed analysis in this EA (i.e., surface and ground water, wetlands, terrestrial and aquatic wildlife, and heritage resources; see section 1.7, Identification of Issues). These descriptions follow an overview of the project area's general setting. Collectively, this information sets the stage for analysis of potential environmental effects as documented in Chapter 4.

3.2 General Setting

The lease modification areas are located on the northern end of Old Woman Plateau, near the southern end of the Wasatch Plateau, a north-south trending high plateau bounded by Sanpete Valley to the west and Castle Valley to the east. The plateau lies within the Basin and Range – Colorado Plateau Transition Physiographic Province. The terrain is rugged, consisting of mountains dissected by a series of drainages that become more deeply incised as they run generally from northeast to southwest. The northern extreme lies in the North Fork Quitchupah Creek Watershed, while the remainder is in the Convulsion Canyon/Quitchupah Creek Watershed. Project area-elevations range from 9,250 atop Duncan Mountain in the north to approximately 7,600 feet in Convulsion Canyon in the south.

The mean annual precipitation is 20 to 25 inches per year. The May through October precipitation is 6 to 8 inches, leaving 12 to 19 inches occurring mainly as winter snow (Forest Service and BLM 1988).

Based on Forest Service vegetation mapping (Forest Service 2007), 13 community types occur in the project area, as listed in Table 3-1. Ponderosa pine/curl-leaf mahogany/manzanita is the dominant community type within the project area, followed by riparian and mountain sage/perennial grass, accounting for approximately 39.5 percent of the project-area vegetation communities. Note that this vegetation mapping is based on photo interpretation and thus is not highly accurate for some vegetation types. Riparian vegetation in particular appears to be overestimated.

Emery, Utah, is the nearest town, lying about 12 miles south and southeast in Castle Valley. Utah State Highway 10 runs north-south through Castle Valley, connecting the small communities of the valley. Interstate 70 runs east-west through Salina Canyon to the south, connecting the valleys flanking the plateau.

Pertinent background on surface and ground water resources, wetlands, wildlife, and heritage resources is provided under respective headings below. Past and current land uses are summarized below in section 4.3, Cumulative Impact Analysis.

Table 3-1. Community types in the West Coal Lease Modifications project area.		
Community Type	**Acres in Project Area**	**Percent of Total Project Area**
Ponderosa pine/curl-leaf mahogany/manzanita	535	15.3
Riparian	449	12.8
Mountain sage/perennial grasses	401	11.4
Mixed conifer/aspen	394	11.2
Gambel oak/mountain juniper	369	10.5
Gambel oak/mountain big sage	362	10.3
Gambel oak/aspen	291	8.3
Aspen/perennial grass	277	7.9
Curl-leaf mountain mahogany	183	5.2
Perennial grass	90	2.6
Mountain shrubs	69	2.0
Pinion-juniper woodland	72	2.0
Unlabeled vegetation types	16	0.5
Total	**3,508 acres**	**100.0%**

3.3 Resources/Issues Brought Forward for Analysis

As discussed above in section 1.7, Identification of Issues, four resources identified through scoping and internal, interdisciplinary review are surface and ground water, wetlands, terrestrial and aquatic wildlife resources, and heritage resources. The Interdisciplinary Team Analysis Record Checklist, was used to identify these issues and is attached as Appendix A.

Each of the four resource-specific sections below is introduced by an issue statement describing the specific, potential effects. A description of key aspects of the affected environment follows, setting the stage for discussion of the environmental consequences of the proposed action and no-action alternatives.

3.3.1 Surface and Ground Water

- Water features in the project area include ephemeral, runoff flows in Duncan Draw, Mud Spring Hollow, Pin Hollow, and Broad Hollow as well as seeps and springs in some of these drainages. Subsidence could impact the quality and hydrology of these surface waters and ground water, and such impacts could have broader effects on the project area's ecosystem.

Evaluation Criteria: Changes in surface or subsurface hydrology due to mining impacts and corresponding changes in the location or discharge of surface springs, seeps, streams, or ponds.

As the project area is not part of any municipal watershed, potential drinking water impacts are not a concern (see Appendix A). Surface and ground water resources in the project area were identified based on a project-area site visit conducted in July 2008 and a review of available information including National Hydrography GIS data, aerial photography, USGS geologic mapping at 1:100,000 and 1:24,000 scale, Utah Division of Oil Gas and Mining data archives, SUFCO overburden coverage, and previous reports addressing hydrology and geology in nearby mining tracts.

3.3.1.1 Surface Water Resources

Note that this section deals with streams, ponds, and troughs in the modification areas. Seeps and springs are discussed below under Ground water Resources.

The project area is located in the headwaters of the Quitchupah Creek drainage including portions of the North Fork Quitchupah Creek and Convulsion Canyon-Quitchupah Creek watersheds. Quitchupah Creek flows into Ivie Creek, a tributary to Muddy Creek which is part of Utah's West Colorado River Watershed Management Unit. The watershed divide is defined by Duncan Mountain (elevation 9,250 feet) and intercepts the northeast corner of the project area.

Three canyons span the project area including Duncan Draw, Mud Spring Hollow, and Pin Hollow/Broad Hollow (Figure 3-1). Convulsion Canyon is located along the southern edge of the project area at approximately 7,600 feet elevation. Stream channels in these project-area canyons support intermittent flow resulting from spring snowmelt and occasional storm events during other times of the year. Perennial flow commences in Convulsion Canyon roughly 0.5 miles east of the project area, below the confluence with East Spring Canyon.

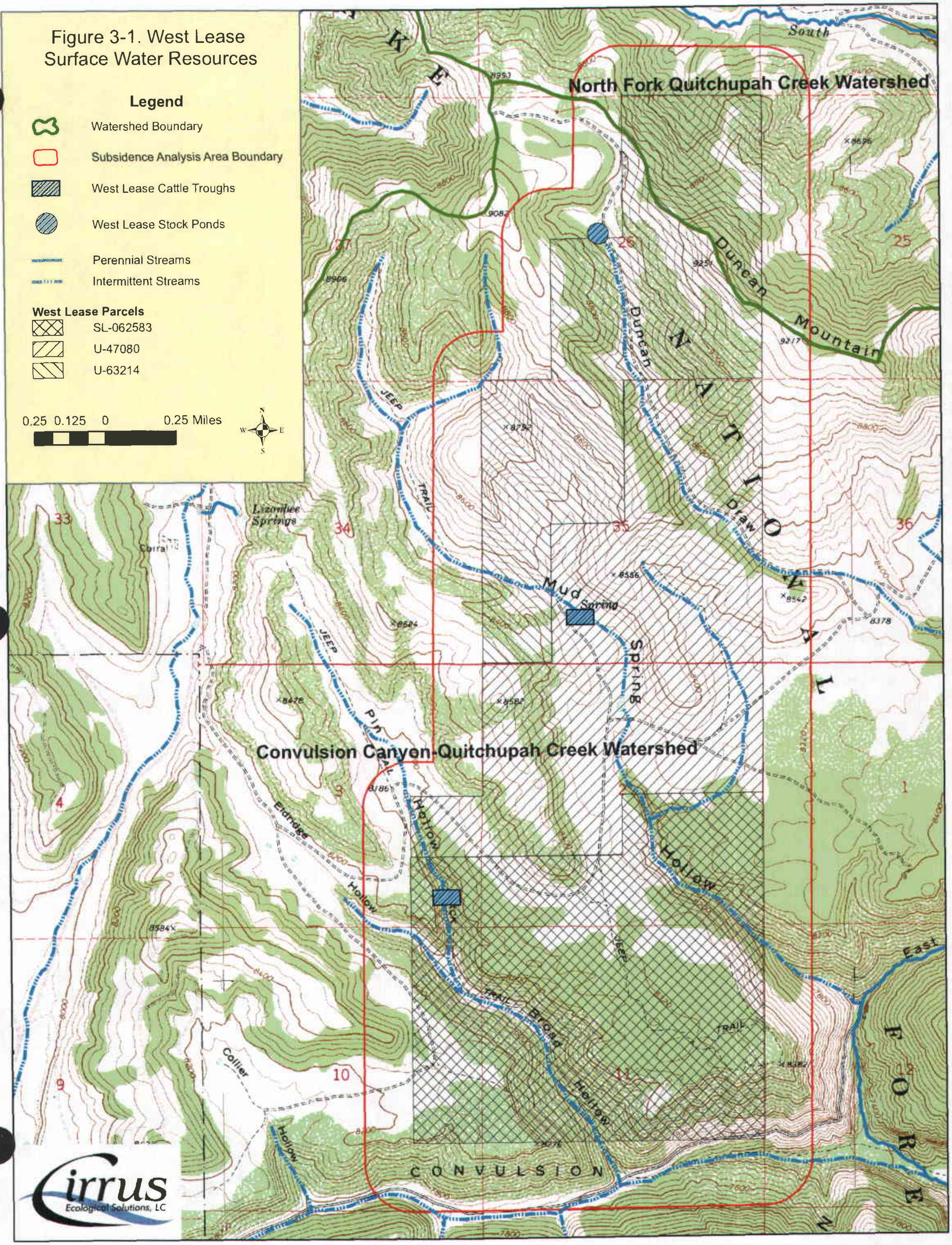
The channel in Duncan Draw begins on the southwest side of Duncan Mountain at an elevation of approximately 8,500 feet. A livestock pond has been created near this location with a berm that collects surface runoff from upslope areas. The surface area of the pond is approximately 1 acre. The channel below the pond is well vegetated throughout much of its length down to the eastern edge of the project area. Localized segments of incised channel with exposed banks comprised of silt/clay soils are present in the upper reaches of Duncan Draw.

The upper, ephemeral stream reaches in Mud Spring Hollow are located outside the northwest project area boundary. The main channel ranges in elevation from about 7,700 to 8,700 feet as it passes through the project area. Similar to Duncan Draw, most of the channel is well vegetated and stable. Localized channel segments in upper Mud Spring Hollow are incised with exposed soil surfaces. Although channel features of this type are unstable and susceptible to erosion, they are not uncommon for headwater streams in the area and represent typical phases of stream morphology as channels adjust to dynamic patterns of precipitation, flow, erosion, and deposition.

Mud Spring Hollow increases in width below 8,300 feet as slopes decrease. Stream channel banks and beds are well vegetated in this reach. Localized segments of stream channel in this area (<100 feet) were observed to have either mud or standing water (Figure 3-1). A cattle trough is located in this area near Mud Spring. The trough is currently in disrepair and no longer connected to the pipeline leading from the spring.

Outcrops of Castlegate Sandstone occur near 8,200 feet elevation and eventually create canyon walls which define the boundaries of Mud Spring Hollow down to the confluence with Convulsion Canyon. The stream channel in lower Mud Spring Hollow contains mature woody vegetation and plant species. Large boulders and bedrock armor the channel bed and banks and stabilize the channel during runoff events.

Figure 3-1. West Lease Surface Water Resources



Pin Hollow enters the project area along the west boundary and eventually joins with Eldridge Hollow above the confluence with Broad Hollow. Upslope areas adjacent to stream channels are defined by canyon walls formed by outcrops of Castlegate Sandstone. At the time of the site visit (July 2008), the lower segment of the stream channel in Pin Hollow contained standing water 3 to 6 inches deep which supported wetland and riparian vegetation. A cattle trough is also located in this area. The trough is filled from a nearby springbox and currently provides water for grazing livestock (Figure 3-1).

Below the confluence of Pin Hollow and Eldridge Hollow, the stream channel in Broad Hollow widens and contains mature shrub and tree species. The channel bottom in this area is comprised primarily of sand mixed with large colluvial material and some bedrock features. Channel banks are stable.

3.3.1.2 Ground Water Resources

Ground water travels through geologic formations underlying the project area. These formations serve as aquifers that support both local and regional flow patterns. The general pattern for ground water flow within the study area is from the recharge areas at higher elevations to the discharge areas at the lower elevations along valleys. Beyond that, site geology controls the patterns, pathways and rates of ground water flow and influences the location and extent of ground water discharge. Ground water is discharged from springs and seeps that support standing water in localized segments of intermittent stream channels in the project area (Figure 3-2).

The surface occurrence of geologic formations is also shown in Figure 3-2. A detailed study of geologic formations in the nearby Muddy Lease Tract area was completed by Anderson (2004) and can be used to describe physical properties of aquifers and ground water movement in the modification areas. The North Horn Formation is the uppermost geologic layer in the project area. The shaley nature of the formation and its occurrence at higher elevations that receive more precipitation makes it vulnerable to mass movement, slope failures, and landslides. The shales and clays of the North Horn Formation serve to retard the vertical flow of water causing ground water to move horizontally along bedding planes or through fractures. Two seeps have been identified that discharge from the North Horn formation on the north face of Duncan Mountain (Figure 3-2). These features are characterized by standing water that collects in surface depressions. No single point of discharge or overland flow extending away from the depressions was identified during the July 2008 field visit.

The next geologic layer, Price River Formation, is lithologically similar to the underlying Castlegate Sandstone, but the formation contains more shale and siltstone, with minor conglomerate and is a slope-former (Anderson 2004). Like the North Horn Formation, the outcrop of the Price River Formation is susceptible to slumping and landslides due to the occurrence of shales and clays.

It is uncertain whether ground water in the North Horn and Upper Price River formations is continuously saturated or whether unsaturated zones occur beneath perched saturated zones. Indications of extensive unsaturated horizons in the Price River and Castlegate Sandstone in drill holes and wells in the adjacent SUFCO Mine and nearby Pines Tract Lease, as reported in the Pines Tract EIS (Forest Service 1999), suggests that perched ground water conditions are likely. In any event, it is clear that the clays and shales within the North Horn and Price River formations severely restrict vertical flow of ground water to deeper units within the study area.

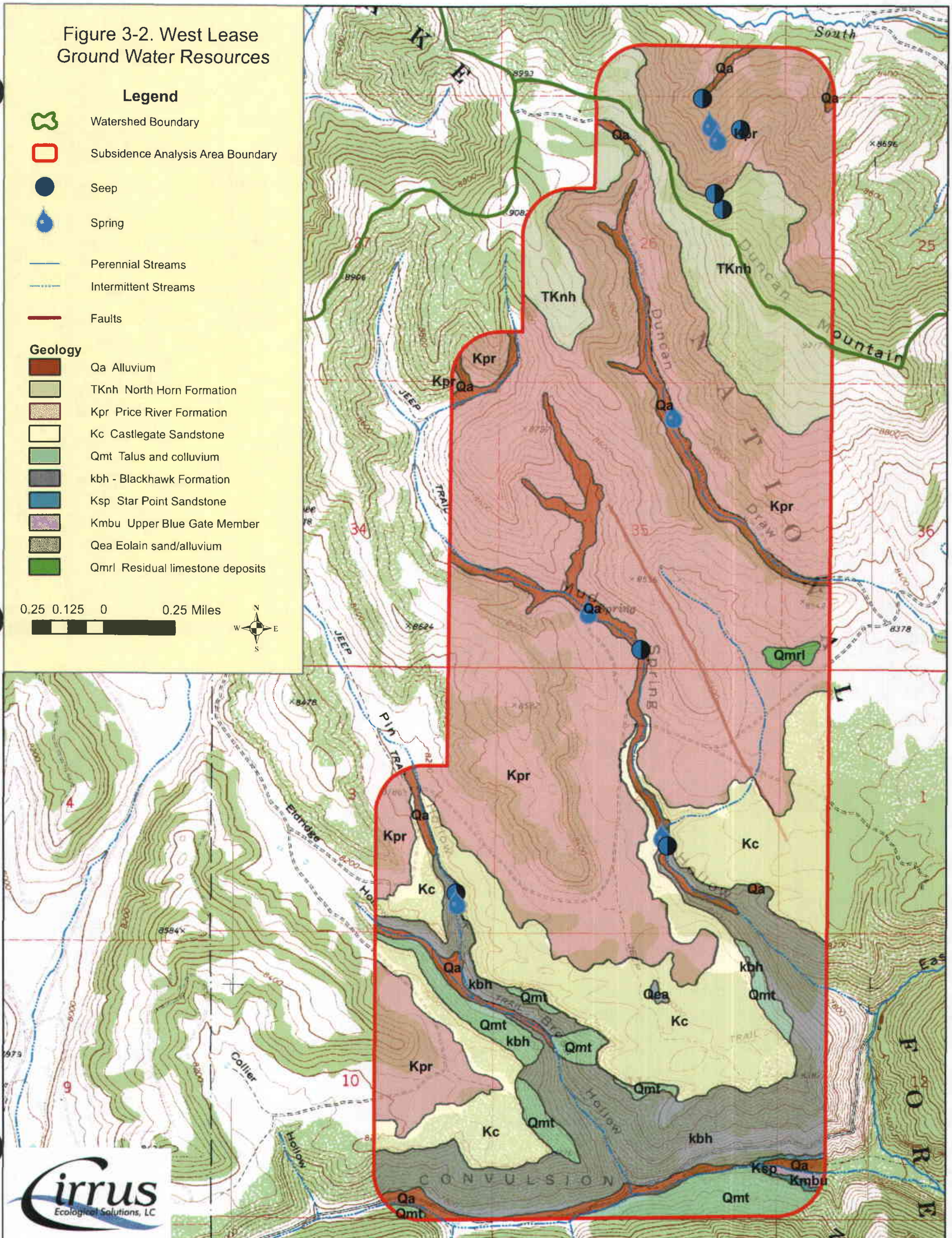


Figure 3-2. West Lease Ground Water Resources

A total of four springs and three seeps occur on the Price River Formation or alluvial material deposited above this formation (Figure 3-2). Two springs and two seeps are on north facing slopes of Duncan Mountain. Discharge from each spring was estimated at less than 2 gallons per minute during the July 2008 field visit. The two seeps consist of standing water collected in shallow depressions. The two remaining Price River springs are located in Duncan Draw and Mud Spring Hollow. Both springs are developed with collection structures (spring box) and protected by fenced enclosures. The spring in Duncan Draw was observed to be dry in July 2008 while the spring box in Mud Spring Hollow contained approximately 12 inches of water. Discharge from this spring box was not observed. Small amounts of standing water (less than 2 inches) were observed in shallow depressions about 1,000 feet below the Mud Spring enclosure. This area extends for roughly 30 feet along the bottom of a swale in Mud Spring Hollow.

Castlegate Sandstone forms a steep cliff escarpment along the edges of lower Mud Spring Hollow, Broad Hollow, and Convulsion Canyon. Near cliff exposures and along channel bottoms, the Castlegate Sandstone becomes friable due to the dissolution of the carbonate cement, thus becoming more capable of supporting active ground water systems (Forest Service 1999). The Final EIS for the Pines Coal Tract determined that reduced vertical and lateral stresses on the Castlegate Sandstone outcrop along the canyon walls has increased fracture widths and hydraulic conductivities. This has apparently enhanced localized recharge of the Castlegate Sandstone that may extend for a distance of about 1,000 feet back from the canyon rims. No springs or seeps were identified in the Castlegate Formation.

The mineable coal seams are found in the lower quarter of the Blackhawk Formation, underlying the Castlegate Sandstone (Anderson 2004). The sandstone units become more separated and isolated toward the base of the Blackhawk, and swelling clays are common throughout this geologic layer. The presence of clay decreases hydraulic conductivity, which impedes vertical flow of ground water within the Blackhawk Formation. Analysis of the tritium and radiocarbon of ground water performed for the Pines Coal Tract EIS (Forest Service 1999) indicated that ground water in the Blackhawk Formation coals is very old (greater than 7,000 to 20,000 years), as compared to the relatively young water in the Castlegate Sandstone springs. The significant differences in water age indicate a lack of transmission between these geologic formations, including an absence of faults that would promote vertical flow.

Two springs and two seeps occur near the Castlegate-Blackhawk contact (Figure 3-2). Discharge from a spring in lower Mud Spring Hollow occurs at the base of a rock escarpment defining the west edge of the canyon. Flows were estimated at less than 0.5 gallons per minute and disappear quickly into the surrounding surface. Standing water was observed in the stream channel roughly 200 feet below the spring and continued downstream for about 75 feet. A spring and seep in Pin Hollow are in the channel bottom roughly 0.5 miles upstream of the confluence with Eldridge Hollow. Discharge from the spring is collected in spring box that fills a nearby cattle trough. Flows from the spring box were estimated at 2 gallons per minute. Standing water (4 to 6) inches deep was observed in roughly 700 feet of stream channel above and below the spring. The origin of the seep is surrounded by abundant riparian vegetation including willows and sedge.

The Star Point Sandstone and Upper Blue Gate Member Formations occur in the lower southeast corner of the project area and are stratigraphically below the Blackhawk Formation (Figure 3-2). The lower Star Point Sandstone is an upward prograding sequence of thin sandstones, siltstones, and shales, which intertongue with underlying formations (Forest Service 1999). No springs or seeps were identified in this area.

Other geologic features in the project area include deposits that have been moved by wind (eolian), water (alluvium), or gravity (talus/colluvium) as well as residual deposits of limestone. The most important of these features is alluvium, due to the interaction of this material with shallow ground water. As noted previously, shallow ground water is captured in alluvial deposits in stream channels and canyon bottoms throughout the project area. The presence of standing water in segments of Mud Spring Hollow and Pin Hollow represent diffuse discharge (seeps) from shallow ground water that has collected in alluvial deposits. Recharge to alluvial deposits occurs on a seasonal basis as direct surface infiltration or as inflow from upstream channel segments.

The extent and duration of shallow ground water in these areas can be somewhat inferred by the type and amount of surface vegetation that is present. Localized areas of riparian vegetation occur along some channel segments, particularly at mid-elevations where stream channels decrease in gradient. Shallow core sampling from alluvial deposits in these areas identified some evidence of mottling and the potential for saturated soil conditions during some part of the year.

3.3.1.3 Water Quality

The quality of mine water discharge is regulated by the Utah Division of Water Quality (Utah DWQ). Analysis results of discharge from the SUFCO Mine to North Fork Quitchupah Creek at permitted discharge point 003 show compliance with permitted limits established by Utah DWQ. In addition, Whole Effluent Toxicity (WET) testing is required to insure that mine discharge is not toxic to aquatic life. The results of WET testing reported in monitoring databases maintained by the Utah Division of Oil Gas and Mining (DOGM) show compliance with applicable standards.

3.3.2 Wetlands

- Isolated, discrete wetlands are associated with Duncan Draw, Mud Spring Hollow, Pin Hollow, and Broad Hollow. Any impacts on surface or ground water quality or hydrology could affect these aquatic ecosystems.

Evaluation Criteria: Changes in wetland hydrology due to mining impacts and corresponding changes in species composition in riparian areas and wetlands.

Wetlands resources in the project area were identified based on a project-area site visit conducted in July of 2008 and a review of aerial photography, including 1-meter resolution National Agriculture Inventory Project (NAIP) regular color aerial imagery from 2004 and 2006 and color infrared imagery from 2004.

Wetlands are defined as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal conditions do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (Federal Register 1982). Wetlands in the project area are typically associated with zones of ground water discharge where saturated soils conditions occur. Wetland hydrology is present in areas that are inundated or saturated to the surface continuously for at least 5 percent of the growing season in most years (Environmental Laboratory 1987). These areas are wetlands if they also meet hydrophytic vegetation and hydric soil requirements.

The boundary between wetlands and uplands may be abrupt, particularly where the wetland edge coincides with a defining change in topography, or may be more gradual where the topographic gradient is less. In the project area, several of the wetland resources occur in areas where the topography is gradual and the change from wetland to mesic meadow to upland occurs over a wider distance.

The determination of the exact wetland boundaries is further complicated by the apparent reduction of water discharge from several of the springs. Vegetation that is persisting may have been established during, and currently reflect, a wetter water regime than now exists on the site. This situation is the case in upper Mud Springs Hollow and Duncan Draw.

Due to the lack of available data that would allow the areas that are technically wetlands to be separated from non-wetland mesic and seasonally mesic meadows, these areas are addressed together as part of the wetland resources in the project area. Wetlands do not occur in Broad Hollow but are found to some degree in the other project area drainages. Table 3-2 lists the wetland resources in the project area.

Table 3-2. Wetland systems in the West Lease project area.

Wetland Resources	Description
Pin Hollow Spring	Small, shaded spring in an otherwise dry canyon. Spring has been developed and piped to a livestock watering trough. Water creates a seepy wetland zone in the bottom of the swale.
Lower Spring/Seep In Mud Springs Hollow	Water is discharged from an outcrop of Castlegate Sandstone and creates a small seepy wetland community in the channel below the rock from which the seep discharges.
Upper Spring In Mud Springs Hollow	The upper Mud Springs Hollow spring has been developed for livestock watering, but the volume of water appears to have diminished and the system was dry in July of 2008. However, wetland sedges and rushes persist and may indicate the presence of seasonal wetland hydrology.
Duncan Hollow Spring	The main spring in Duncan Hollow is outside of the project area, but the mesic meadow below the springs crosses the project area. Areas of seasonal wetland may persist in the project area.
Duncan Mountain Springs	The north side of Duncan Mountain has a system of springs and seeps. Wetland and riparian vegetation are associated with these features.

3.3.3 Terrestrial and Aquatic Wildlife Resources

- Several Forest Service sensitive species and other special status species such as management indicator species (MIS) and migratory birds potentially occur in the project area and could be affected indirectly by subsidence.

No federally listed or candidate plant or wildlife species, or their critical habitats, have been identified in the project area (see Appendix A). A Biological Assessment documenting this conclusion has been prepared for the project. A Biological Evaluation providing detailed analysis of effects on Forest Service sensitive species and a MIS report addressing these species as well as other special status species were also prepared. All are included in the project record.

Evaluation Criteria: Changes in populations or habitat conditions for special status wildlife species due to mining impacts, particularly aquatic and riparian species given the limited range of potential surface effects.

This assessment of potential wildlife impacts was based on a site visit completed in July 2008, review of NEPA and other pertinent documents regarding similar projects and/or similar habitats, and knowledge of the habitat requirements of special status species potentially occurring in the project area. Information on MIS species was provided by the Fish Lake National Forest (Rodriguez et al 2006).

Much of this discussion is summarized from the Biological Evaluation prepared for this project and included in the project record (Cirrus 2008a).

3.3.3.1 Forest Service Sensitive Species

The habitat types occurring in the project area are listed above (see 3.2, General Setting). Table 3-3 lists the Forest Service Intermountain Region sensitive wildlife species and rationale why each was or was not considered in this analysis.

Table 3-3. Suitability of habitat in the project area for Forest Service R4 Sensitive wildlife species found on the Fishlake National Forest (Forest Service 2003).

Species	Habitat Description	Analysis of Habitat Suitability/Rationale
	Mammals	
Spotted bat *Euderma maculatum*	Ponderosa pine, pinyon-juniper woodlands, and shrub desert. Elevations up to 10,600 feet. Roosts in crevices of rocky cliffs.	**Considered.** Ponderosa, pinyon-juniper and shrub habitat is present.
Townsend's big-eared bat *Corynorhinus townsendii pallescens*	Semidesert shrublands, pinyon-juniper woodlands, and open montane forests. Elevations up to 9,500 feet. Roosts in caves and abandoned mines.	**Considered.** Suitable foraging habitat present; roosts limited.
Pygmy rabbit *Brachylagus idahoensis*	Areas with tall, dense sagebrush. Requires deep soils to excavate burrows.	**Not Considered.** Suitable habitat not present.
	Birds	
Bald eagle (*Haliaeetus leucocephalus*)	Bald eagles nest almost exclusively near lakes, rivers, or sea coasts. Bald eagle winter range usually includes areas of open water such as lakes or major rivers, but may also include arid valleys. Winter roosting habitat can be large roost trees located along rivers, lakes, or reservoirs, or as far as 20 miles from water.	**Not Considered.** Bald eagles are present on the Forest in the fall, winter, and spring. There are no known winter concentration areas on the Forest. Single individuals or pairs have been documented over wintering on the District.
Northern goshawk *Accipiter gentilis*	Habitat includes a wide variety of forest ages, structural conditions, and successional stages for foraging. Generally nests in coniferous, mixed coniferous, and riparian (aspen stringers) forests.	**Considered.** There are known goshawk territories in the vicinity of the project area.
Peregrine falcon *Falco peregrinus anatum*	Nest sites are on cliffs in mountainous areas or in river canyons and gorges. Forage in riparian areas or in open meadows.	**Not Considered.** Suitable cliff habitat for nesting and foraging not present.
Flammulated owl *Otus flammeolus*	Mature pine, mixed conifer and aspen forests. Snags with cavities required for nesting.	**Considered.** Suitable habitat is present.
Three-toed woodpecker *Picoides tridactylus*	Coniferous and mixed forest types at elevations up to 9,000 feet. Requires snags for nesting and foraging.	**Considered.** Suitable habitat is present.
Greater sage-grouse *Centrocercus urophasianus*	Sagebrush communities used during all life cycle stages. Riparian meadows, springs, and streams are also used during late brood-rearing.	**Considered.** Suitable sage, habitat present. Active leks recorded nearby.

Table 3-3. (cont'd) Suitability of habitat in the project area for Forest Service R4 Sensitive wildlife species found on the Fishlake National Forest (Forest Service 2003).		
Species	**Habitat Description**	**Analysis of Habitat Suitability/Rationale**
	Fish	
Bonneville cutthroat trout *Oncorhynchus clarki utah*	Small headwater streams with cool, clear water, pools, and well-vegetated streambanks. Clean, gravel substrate in cool water required for spawning. May also inhabit lakes.	**Not Considered.** Suitable habitat (perennial streams and lakes) not present.
Colorado River cutthroat trout *Oncorhynchus clarki pleuriticus*	Headwater streams and lakes with cold, clean water of the Colorado river drainage system; only occurs on the Loa Ranger District of the Fishlake National Forest.	**Not Considered.** Suitable habitat (perennial streams and lakes) not present.

The potential effects on the spotted bat, Townsend's big-eared bat, northern goshawk, flammulated owl, three-toed woodpecker, and greater sage-grouse are discussed below in Chapter 4.

3.3.3.2 Management Indicator Species

The use of MIS to monitor habitats and associated species is described in *Life History and Analysis of Endangered, Threatened, Candidate, Sensitive, and Management Indicator Species of the Fishlake National Forest, Version 4.1* (Rodriguez et al. 2006). Table 3-4 shows the suitability of habitat for MIS on the FLNF.

Table 3-4. Suitability of habitat for Fishlake National Forest Management Indicator Species.[1]

Species	**Suitability of Habitat for Management Indicator Species**	
	Suitable	**Habitat Unsuitable Based on the Following**
Elk	X	
Mule deer	X	
Northern Goshawk	X	
Cavity Nesters (hairy woodpecker, western bluebird, and mountain bluebird)	X	
Sage Nesters (Brewer's sparrow, vesper sparrow, and sage thrasher)	X	
Riparian Nesters (Lincoln's sparrow, yellow warbler, song sparrow, and MacGillivray's warbler)	X	
Bonneville Cutthroat Trout		X—No perennial streams are located in the project area.
Colorado River Cutthroat Trout		X—No perennial streams are located in the project area.
Resident Trout (rainbow, brown, brook, cutthroat, and lake)		X—No perennial streams are located in the project area.
Aquatic Macroinvertebrates	X	
Rydberg's Milkvetch		X—Associated with tertiary igneous gravels. No such habitat located in the project area.

[1]Habitat characteristics for each of the following species was reviewed and based on information found in Rodriguez et al. (2006).

Because population trend is best addressed at a much larger scale than the project level, data from organizations such as the Utah Division of Wildlife Resources, the Nature Conservancy (NatureServe Explorer), and the United States Geological Survey's Breeding Bird Survey (BBS) were used in the discussions on trend. For far ranging species such as elk that can range across multiple forest boundaries and land ownerships, broad scale data were obtained from the Division of Wildlife Resources, Southern Region (Rodriguez et al. 2006).

Based on this assessment of habitat suitability, the analysis summarized in Chapter 4 focuses on potential effects on elk; mule deer; northern goshawk; the noted cavity, sage, and riparian nesters; and aquatic macroinvertebrates.

3.3.3.3 Migratory Birds

Executive Order 13186, signed on January 10, 2001, directs Federal agencies to evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern. The most recent list of migratory bird species of concern was developed by the U.S. Fish and Wildlife Service (FWS) in *Birds of Conservation Concern 2002* (FWS 2002). In that publication, the migratory bird species of concern are delineated within separate Bird Conservation Regions (BCR) in the United States.

The proposed action would occur in BCR 16 (Southern Rockies/Colorado Plateau) on lands administered by the Fishlake National Forest. There are 29 species of concern listed for BCR 16 (Appendix C). A number of these species could occur on a routine or incidental basis in the modification areas.

3.3.4 Heritage Resources

- Surface impact would be limited to subsidence. Areas of concern for heritage resources include those subject to potential rockfall and surface cracking.

Impacts on paleontological resources are not anticipated due to the nature of the anticipated disturbance. The proposed operations would create little or no surface disturbance. Required mitigation (Forest Service lease stipulation no. 1, cessation of work and notification of agency archaeologists) would avoid impacts on any buried resources encountered during development. (See Appendix B.)

Evaluation Criteria: Number, location, and description of known heritage resources located in areas subject to potential mining-induced subsidence.

A Class I search of the heritage files housed with the Utah State Historic Preservation Office (SHPO) was conducted. In addition to the SHPO files search, supplementary record searches were conducted to ensure a complete data set of information regarding pre-existing identified heritage resources within the West Lease project area. These additional record searches were undertaken at the offices of the regulatory agencies involved, i.e., Richfield BLM and the Richfield Fishlake National Forest.

Together, these file searches compiled information relating to previous archaeological surveys and recorded heritage resources within and around the West Lease project area. Once the file searches were complete Class II and III on-site inventories of the project area were completed. The less intensive Class II inventory focused on steep ridges and slopes, and remaining, higher potential areas were covered by the Class III inventory.

A detailed report on the heritage resource investigation (Earthtouch Inc. 2008) was prepared and is included in the project record. The report was also submitted to the SHPO, whose concurrence with the findings will precede any decision regarding this proposed action.

There are 15 identified archaeological sites within the West Lease project area (see Table 3-5), including three previously identified sites and 12 sites identified through this survey. Six of the sites (42SV3209, 42SV3211, 42SV3212, 42SV3213, 42SV3247, and 42SV3248) are recommended as eligible for inclusion to the National Register of Historic Places (NRHP). The remaining nine are recommended as not eligible for inclusion to the NRHP. All six of the recommended eligible sites within the project area are rock shelters with associated artifacts and/or rock art.

Table 3-5. Heritage Resources within the West Lease project area.

Heritage Resource	Description	Eligibility
42SV1386*	Prehistoric lithic scatter	Not eligible
42SV1031*	Prehistoric lithic scatter	Not eligible
42SV2688*	Prehistoric lithic scatter	Not eligible
42SV3207	Prehistoric lithic scatter	Not eligible
42SV3208	Prehistoric lithic scatter	Not eligible
42SV3209	Prehistoric rock shelter	Eligible
42SV3210	Prehistoric lithic scatter	Not eligible
42SV3211	Prehistoric rock shelter	Eligible
42SV3212	Prehistoric rock shelter	Eligible
42SV3213	Prehistoric rock shelter	Eligible
42SV3214	Prehistoric lithic source	Not eligible
42SV3215	Prehistoric lithic scatter	Not eligible
42SV3246	Historic debris scatter	Not eligible
42SV3247	Possible prehistoric rock shelter	Potentially eligible
42SV3248	Fremont rock shelter	Eligible

*Previously recorded sites.

Potential effects on the six eligible sites are discussed below in Chapter 4.

4.0 ENVIRONMENTAL IMPACTS

4.1 Introduction

This section identifies the direct, indirect, and cumulative impacts anticipated for the proposed action and no-action alternative. The four resource areas/issues addressed are surface and ground water, wetlands, terrestrial and aquatic wildlife, and heritage resources (see section 1.7, Identification of Issues, above).

4.2 Direct/Indirect Impacts

4.2.1 Alternative A – Proposed Action

4.2.1.1 Resource 1: Surface and Ground Water

Methodology

The assessment of impacts described below draws in large part from an analysis completed for the nearby Greens Hollow tract (Maleki 2008). A review of hydrology, geology, overburden depths, and mining techniques indicate the two areas are similar and would therefore exhibit comparable subsidence impacts. In addition, much of the assessment methodology used by Maleki (2008) draws from subsidence impacts observed at other Utah mines developed in the Hiawatha coal seam and is applicable to the modification areas.

The following section provides background information on mining-induced subsidence, the processes it can trigger, and the potential effects of these processes on surface and ground water resources. This background discussion is followed by a section detailing how these processes are anticipated to play out in the modification areas.

Background

Longwall mining activities result in subsidence-induced ground movements and other changes in geology and topography. Potential impacts of this mining-induced subsidence include lower surface elevations, changes in the gradient of streams, loss of water to subsidence-induced cracks, interception and diversion of ground water flow paths, and water quality impacts from mined areas and mine water discharge. These impacts can affect streams, springs, seeps, and ponds. The vertical distance between the surface water body and the mined coal and the geology underlying the stream channel or spring are relevant considerations, as is experience at mines in the same coal field.

Decreases in surface elevations following subsidence are evaluated as a percentage of extraction height. A review of subsidence data from mines near the SUFCO Mine indicated subsidence factors ranging from 45 to 68 percent of extraction height depending on panel width-to-depth ratios. Changes in surface elevation are greatest at the middle of longwall panels, minimal near gate roads, and muted somewhat based on depth of overburden. In general, changes in surface slope are less than 2 percent and not visually discernable due to gradual changes and variations in local topography. Consequences of subsidence under streams can be evident if the change in channel gradient is sufficient to create pools. (Maleki 2008.)

Surface cracks develop during subsidence as tension develops behind the subsidence wave. Healing of surface cracks occurs quickly in areas that experience the full cycle of subsidence, including tension followed by compression. Permanent tensile cracks can occur at the surface near edges of longwall panels and gate roads where permanent tension exists between subsided and non-subsided areas. Development of these types of cracks is particularly evident in areas where geologic strata are brittle, such as Castlegate Sandstone. Surface tensile cracks have been observed in Castlegate Sandstone above longwall mining operations in nearby mining tracts even though the sandstone is about 800 feet to 1,000 feet above the mine workings. Tensile cracks are typically shallow and generally considered not to extend below 50 feet. (Maleki 2008.)

Ground water flow paths can be disturbed during subsidence. Shallow ground water is found in coarse material surrounding many stream channels or in areas where deeper infiltration is limited by impervious layers. Movement of deeper ground water flow occurs preferentially along subsurface fractures or more slowly through porous material in aquifers. Shallow ground water flow can be diverted by development of surface or shallow subsurface tensile cracks. Subsidence impacts on deep ground water flow paths generally extend upward from the mined layer through a fractured zone equivalent to 30 to 60 times mineable thickness. In general, fractured zones do not result in diversion of regional flow patterns. As flow paths are disturbed during subsidence tension and compression phases, the rate, timing, and location of ground water discharge can be influenced.

Water quality impacts associated with underground coal mining occur when surface water or ground water is contaminated by mining activities. Ground water inflow to the mine can be contaminated as it comes in contact with mine equipment or materials introduced into the mine. Long-term oxidation of this material and rock surfaces exposed during mining can influence water chemistry. Surface water quality can be influenced by mine discharge as well as surface runoff from areas used to store mine tailings and equipment, or from construction of new facilities such as roads, vent shafts, or power lines.

Modification Area Effects

Figure 4-1 shows depth of overburden above the Upper Hiawatha coal seam, geologic formations, and water features in the project area. Due to the stratigraphic location of the Upper Hiawatha coal seam and the mine access road, it is unlikely that mine development (and subsidence impacts) will occur along the south end of the tract.

Based on the reported subsidence factors of 45 – 68 percent of extraction height, maximum elevation change on the modification areas should be approximately 8 feet in zones with overburden depths of 1,000 – 2,200 feet. As shown in Figure 4-1, this covers the majority of the project area. Maximum elevation change following subsidence in areas with overburden less than 1,000 feet would be somewhat greater than 8 feet. Changes in surface slopes resulting from differential subsidence would be moderate (generally less than 1 to 2 percent) at most overburden cover depths in the modification areas, and thus vertical subsidence would likely not be visually discernable because of gradual changes in surface slopes.

Changes in channel gradient of intermittent streams in the project area would increase or decrease depending on location of stream channels with respect to gate roads and longwall panel boundaries. Channel slopes would increase where streams enter the subsidence zone and decrease where channels leave the subsidence zone. Changes in channel gradient may become more abrupt near the south end of the project area where overburden depths are shallower and the subsidence factor is greater. However, observed channel gradients are greater here as intermittent stream channels drop quickly down to Convulsion Canyon. As a result, any change in stream gradients or other geomorphic features following subsidence in this area would likely be indistinguishable from existing conditions.

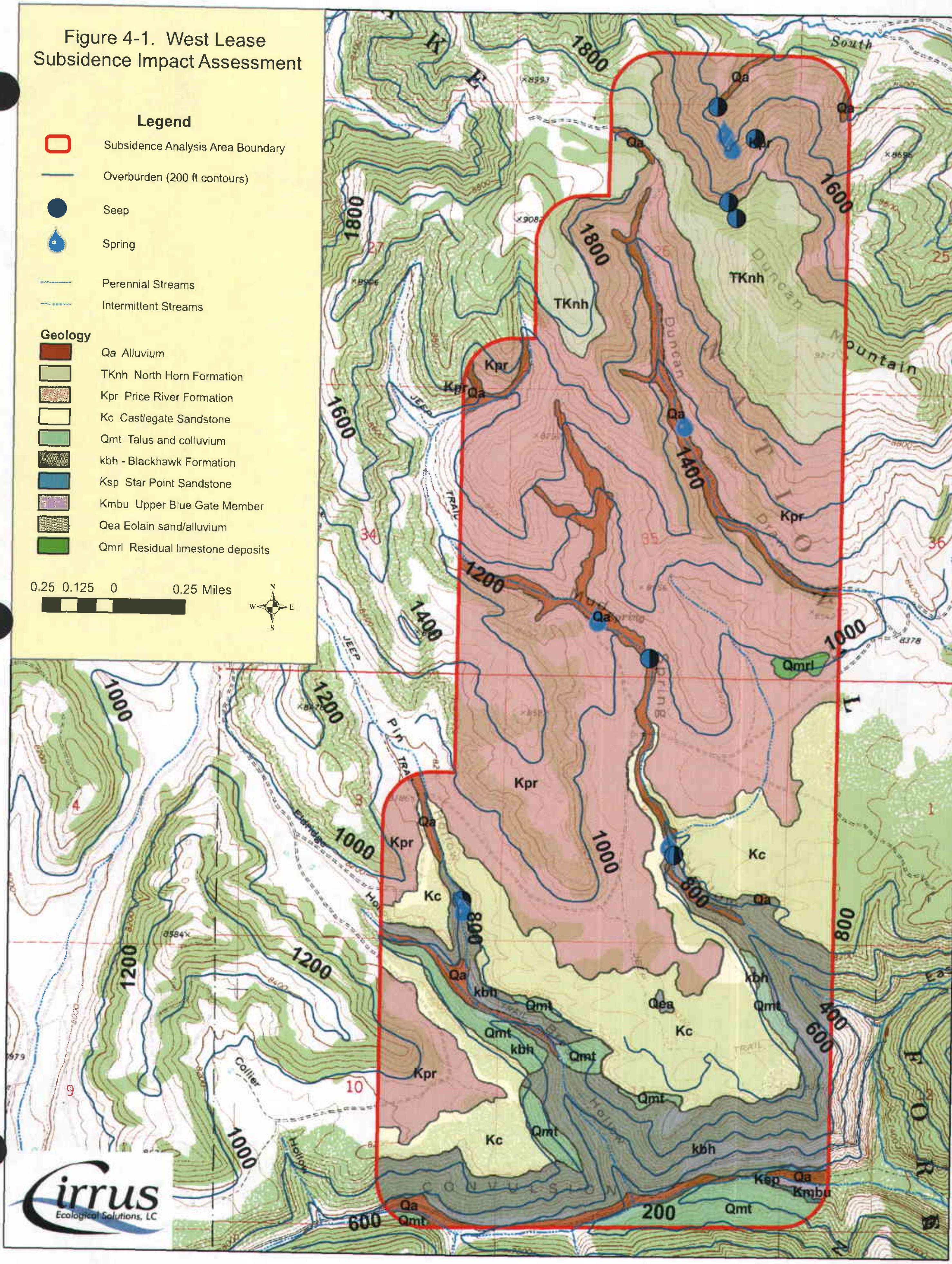


Figure 4-1. West Lease Subsidence Impact Assessment

Permanent loss of surface water to underground mine workings would be unlikely in most of the project area. Extension and expansion of existing fracture systems and upward propagation of new fractures rarely extends upward more than 60 times minable coal thickness (Maleki 2008) or approximately 720 feet. Therefore intermittent channels located in areas with overburden depths of this amount or less (see Figure 4-1), including Broad Hollow and lower segments of Mud Spring Hollow and Pin Hollow, would have some short-term potential to lose seasonal flow to the fracture zone. Due to the alluvial deposits found in these areas, it is likely that any surface cracks which develop in channel segments would likely fill quickly with bedload material generated during spring runoff or intense storm events. However, loss of some water could continue if cracks are filled with coarse material such as gravel or sand that easily transmit water.

All springs, seeps, stock ponds, and intermittent stream channels located within the area of disturbance by mine subsidence could potentially be affected by surface tensile cracks that develop parallel to the subsidence front as the mine advances. Tensile cracks that appear in the soil, shale, and mudstone layers near the surface in the modification areas would be expected to heal quickly following the compression phase of subsidence. The probability of surface tensile fractures affecting springs, seeps, and stock ponds located in upper Mud Spring Hollow, Duncan Draw, and on Duncan Mountain is low and generally decreases with increasing overburden depths. Any short-term loss of seasonal stream flow in intermittent channels to surface tensile cracks would enhance the rate of subsurface flow in the fractured bedrock and alluvium downstream of the point of loss and would eventually resurface in lower channel segments.

Since the potential for permanent surface tensile cracks is increased by brittle geological strata such as Castlegate Sandstone and shallow overburden depths, the potential for developing fractures that would result in a loss of water is greater for springs and seeps located on sandstone units at the south end of the modification areas than for other areas.

Two springs and two seeps are located in Pin Hollow and lower Mud Springs Hollow near the Castlegate/Blackhawk contact (see section 3.3.1.2, Ground Water Resources). Overburden depth at these two locations is approximately 800 feet (Figure 4-1). It is unlikely that the extent of the fractured zone at these two locations would reach the surface. However, development of surface or shallow subsurface tensile fractures could occur, particularly if boundaries of gate roads and longwall panels were located in the area. Any sandstone material that is present at these locations, would not only increase the potential risk but would also extend the amount of time needed to heal cracks. This potential is greater in comparison to other locations where shale, mudstone, and other fined grained materials occur. If surface or shallow subsurface tensile fractures developed at or near these water features, water could be diverted to a downslope location. The likelihood of this occurrence is greater in comparison to water features located on other geologic formations and at deeper overburden depths.

In terms of stock water, the pond in Duncan draw and the trough at Mud Spring (dry, apparently disused, and disconnected from the spring) would not likely be affected in the long term. The spring/seep used to fill the trough in Pin Hollow and spring/seep in lower Mud Spring Hollow (if it is used by livestock) could potentially be affected in the long term or permanently.

The potential for transbasin diversion of mine water discharge depends upon the location of the discharge to the surface and the ultimate fate of the water intercepted by mine workings. Mine water discharge associated with this project would occur at the current SUFCO Mine point of discharge to North Fork Quitchupah Creek. This point of discharge is located in the Quitchupah Creek basin along with the entire West Lease Tract, therefore no transbasin diversions would occur.

Water conveying faults are not expected to be encountered during underground mining within the West Lease Tract. Geologic studies completed in nearby tracts have determined minimal faulting at levels that are not conducive to rapid transmission of water. Furthermore, analysis of tritium and radiocarbon concentrations performed for the Pines Coal Tract EIS (Forest Service 1999) found ground water in the Blackhawk Formation coals to be very old (greater than 7,000 to 20,000 years), and likely absent of faults that would transmit younger water from other geologic strata. Ground water intercepted by the mine is expected to be water stored in sandstone lenses or paleo channels and perched zones that have no hydraulic connection with surface water systems.

No new surface developments are associated with this project; therefore, the only surface water quality impacts would be associated with mine water discharge to North Fork Quitchupah Creek.

The quality of mine water discharge or mine water that accumulates in mined out areas would be similar to the quality of ground water in the overlying geology. The concentration of some constituents would increase due to oxidation of sulfide minerals in exposed rock and chemical interactions with metal material that cannot be removed as the mine advances or retreats. After mining is completed and the underground mine workings are flooded, the dissolved oxygen levels in the mine water would be depleted. As this occurs, the rate of oxidation of sulfide minerals and ferrous metals would decline and eventually cease. At some point, dissolved metals could begin to precipitate as sulfide minerals that would be contained within the underground mine workings.

The quality of mine water discharge is regulated by the Utah DWQ. The water quality of the current SUFCO mine discharge is thought to be most representative of future mine water discharges or accumulation in the mine.

4.2.1.2 Resource 2: Wetlands

Potential impacts on wetlands would be indirect, caused by changes in hydrology due to mining-induced subsidence. Subsidence effects on hydrology are summarized in the preceding section (4.2.1.1 Surface and Ground Water).

All drainages in the modification areas with the exception of Broad Hollow support limited areas of wetlands and non-wetland mesic or seasonally mesic meadows (see section 3.3.2, Wetlands) associated with springs and seeps or areas with seasonally high water tables. As indicated above (Section 4.2.1.1 Surface and Ground Water), all these springs and seeps could potentially be affected by surface tensile cracks that develop parallel to the subsidence front as the mine advances. However, the likelihood that springs and seeps and associated wetlands in upper Mud Springs Hollow and Duncan Draw and on Duncan Mountain would be affected by subsidence is low and decreases with increasing overburden depth, and any such hydrologic effect would likely be temporary. Cracks would be expected to heal during the compression phase of subsidence and be plugged with finer textured soil, shale, or mudstone. Any short-term loss of seasonal stream/spring discharge to surface tension cracks that did occur would enhance the rate of subsurface flow in the fractured bedrock and alluvium downstream of the point of loss and would resurface lower in the drainage.

The two springs in the southern portion of the modifications areas, lower Mud Springs Hollow and Pin Hollow, lie in areas of shallower overburden, about 800 feet. Permanent surface or subsurface tensile cracks could occur, particularly if boundaries of gate roads and longwall panels occurred in the area. Sandstone in the area would increase the risk and the amount of time it would take for the cracks to heal. If cracks developed, they could divert water downslope of the point of loss, resulting in a contraction or loss of wetland/mesic meadow vegetation at these locations, depending on the magnitude of the hydrologic change. The amount, extent, and duration of water diverted from these seeps and springs would depend, in part, on placement of gate roads and longwall panels and the extent and depth of cracks that occurred following subsidence.

Wetlands/mesic meadows in the project area could be subject to either temporary or permanent hydrology impacts as a result of subsidence. For the purpose of this analysis, temporary is defined as changes in hydrology that last 1 year or less, while permanent is defined as changes in hydrology that last longer than 1 year. If temporary changes in hydrology occurred while subsidence cracks healed, the effect on wetland and riparian vegetation would depend on several variables, including weather conditions during that period (i.e., temperature, precipitation patterns, etc.). If climatic conditions were not too severe, wetland vegetation would likely persist and recover when the hydrology returned. Effects may be similar to those associated with the fluctuations between wet and dry years. If water were permanently diverted to a new, downslope location, a corresponding loss of wetlands would occur. Wetland or riparian vegetation would likely develop at the new downstream location. However, it would take time for the new wetlands to become established and to support similar levels of function as the older wetlands.

4.2.1.3 Resource 3: Terrestrial and Aquatic Wildlife

Region 4 Forest Service Sensitive Species

The project area contains potentially suitable habitat for the spotted bat, Townsend's big-eared bat, northern goshawk, flammulated owl, three-toed woodpecker, and greater sage-grouse (section 3.3.3.1, Forest Service Sensitive Species). According to the Biological Evaluation prepared for the project (Cirrus 2008a), individuals of three sensitive species could be adversely affected by the proposed action. The species and rationales are as follows:

- Spotted bat (due to potential reduction in roosting habitat in rock crevices due to escarpment failure).

- Townsends big-eared bat (due to potential reduction in roosting habitat in caves and rocky outcrops).

- Greater sage-grouse (due to potential reduction in brood-rearing habitat in wetlands and mesic meadows).

These effects could involve individuals but would not affect population viability or contribute to a trend toward federal listing. In terms of bat roosting, while escarpment failure might damage existing habitat the impact would be offset by creation of new habitat. Regarding sage-grouse, as discussed above (section 4.2.1.2, Wetlands), the potential for impacts on wetland habitats is low in all but the southern portion of the modification areas, and over time lost wetland habitats would be replaced at the new locations where water surfaced. Further, surveys were completed in July 2008 and no evidence of sage-grouse use of the project area was found.

The remaining three species, northern goshawk, flammulated owl, and three-toed woodpecker, would not be affected due to the absence of surface-disturbing activities that would disturb individuals or damage their habitat or prey base.

Management Indicator Species

This analysis focuses on potential effects on elk; mule deer; northern goshawk; the noted cavity, sage, and riparian nesters; and aquatic macroinvertebrates (see section 3.3.3.2, Management Indicator Species). As detailed in the MIS report prepared for this project (Cirrus 2008b), several

MIS could be adversely affected by the proposed action. The species and rationales are as follows:

- Riparian nesters (due to potential reduction in riparian nesting habitats).

- Aquatic macroinvertebrates (due to potential displacement of aquatic, spring/seep-fed habitats).

The scope and magnitude of potential adverse effects is low due to two factors. First is the limited extent, spotty distribution, and relatively low quality of the riparian and aquatic habitat present in the modification areas. Second is the self-correcting nature of impacts on the hydrology supporting riparian and aquatic habitats discussed above. Forest-wide populations and trends would not be affected.

The remaining six MIS would not be affected due to the absence of surface-disturbing activities that would disturb individuals or damage their habitat or prey base.

<u>Migratory Birds</u>
BCR 16 (Southern Rockies/Colorado Plateau) supports 29 migratory bird species of concern listed for BCR 16 (see section 3.3.3.3, Migratory Birds), a number of which could occur on a routine or incidental basis in the diverse habitats represented in the modification areas. Based on the MIS and migratory bird report prepared for this project, three of these species (yellow-billed cuckoo, peregrine falcon, and flammulated owl) have been addressed in the Biological Assessment and/or Biological Evaluation (Cirrus 2008c and Cirrus 2008a) prepared for this project and determined to be unaffected because habitat is either not present or would not be affected.

Of the remaining species, those that nest in riparian habitats could be adversely affected for the reasons outlined above (see Management Indicator Species), that is, due to potential reduction in riparian nesting habitats. Again, the scope and magnitude of potential adverse effects is low due to the limited extent, spotty distribution, and relatively low quality of the riparian and aquatic habitat present in the modification areas and to the self-correcting nature of hyrologic impacts on habitat.

Another potential impact on migratory birds is subsidence-induced failure of escarpments and its effect on cliff-nesting species. Species including prairie falcons and golden eagles could lose nesting sites due to escarpment failure. However, nesting sites are generally not limiting in the region, and unless failure occurred during brooding and rearing, the effect would be negligible. New habitat would be created to offset any loss of existing habitat to some degree.

Overall, the proposed action should have no notable, adverse impact on migratory birds.

4.2.1.4 Resource 4: Heritage Resources

If the proposed action were pursued, then subsidence associated with the subsurface mining could impact sites 42SV3209, 42SV3211, 42SV3212, 42SV3213, 42SV3247, and 42SV3248, all of which are prehistoric rock shelters with associated artifacts and/or rock art. Subsidence could potentially damage or destroy these archaeological sites.

However, Forest Service lease stipulation no. 1 (see Appendix B) would be in force to prevent or mitigate these potential impacts as well as impacts on other heritage or paleontological resources discovered during future mining operations. Under this stipulation, Ark would be required to complete any further studies and inventories deemed necessary and to develop a plan, subject to Forest Service approval, to protect heritage and paleontological resources from damage or to mitigate such impacts.

Avoidance of damage would entail requiring non-subsidence mining under the escarpments and outcrops where these sites are located. Mitigation would involve a data recovery plan including a detailed surface recording of all artifacts, documentation of rock art panels and systematic subsurface excavation of cultural deposits.

4.2.1.5 Mitigation Measures

The only notable impacts remaining with the lease terms, conditions, and Forest Service stipulations in place would be those associated with long-term or permanent diversion of flows from the springs and seeps in lower Mud Springs Hollow and Pin Hollow (see sections 4.2.1.1, Resource 1: Surface and Ground Water; 4.2.1.2, Resource 2: Wetlands); and 4.2.1.3, Resource 3: Terrestrial and Aquatic Wildlife).

For these important stock water sources, mitigation would be to replace the water at its source, either by trucking or piping it from the new spring/seep location or another source. Alternatively, new spring/seep locations caused by hydrologic changes might meet stock water needs. This mitigation would be effective in wholly offsetting the impact in terms of stock water. Any loss of wetlands would be mitigated as required by the Army Corps of Engineers under section 404 of the Clean Water Act.

4.2.1.6 Residual Impacts

With the cited mitigation in place, the only residual impact would be the unlikely potential for minor and temporary displacement of surface water resources on Duncan Mountain and in Duncan Draw and upper Mud Spring Hollow, and the somewhat higher potential for longer-term displacement of spring/seep flows in lower Mud Springs Hollow and Pin Hollow. As noted above, while stock water would be replaced through mitigation, this measure may or may not mitigate impacts on wetlands and the wildlife species dependent on them.

4.2.1.7 Monitoring and Compliance

Monitoring for compliance with permit terms is a component of federal land management agencies' administration of mining activities on lands under their jurisdiction. In this case, both the BLM and the Fishlake National Forest would play roles in seeing that Ark complied with both the permits terms, conditions, and stipulations as well as with any mitigation required by the Responsible Official's decision. Responsibility for insuring compliance with underground (i.e., mine plan) matters would lie with the BLM, while the Fishlake National Forest would monitor compliance with stipulations and mitigation measures protecting surface resources.

4.2.2. Alternative B – No Action

4.2.2.1 Resource 1: Surface and Ground Water

Under this alternative, the direct, indirect, and cumulative impacts on surface and ground water identified above (see section 4.2.1.1 Resource 1: Surface and Ground Water) for the proposed action would not occur. These resources would continue to be subject primarily to the forces of nature (e.g., climatic variation and earthquakes).

4.2.2.2 Resource 2: Wetlands

Under this alternative, the direct, indirect, and cumulative impacts on wetlands and mesic meadows identified above (see section 4.2.1.2 Resource 2: Wetlands) for the proposed action would not occur. These resources would continue to be subject primarily to the forces of nature (e.g., climatic variation) and ongoing grazing with its associated trampling and herbivory of wetland plants.

4.2.2.3 Resource 3: Terrestrial and Aquatic Wildlife

Under this alternative, the direct, indirect, and cumulative impacts on terrestrial and aquatic wildlife identified above (see section 4.2.1.3 Resource 3: Terrestrial and Aquatic Wildlife) for the proposed action would not occur. These resources would continue to be subject primarily to the forces of nature (e.g., climatic variation) and ongoing grazing with its associated impacts on upland and aquatic habitats.

4.2.2.4 Resource 4: Heritage Resources

Under this alternative, the direct, indirect, and cumulative impacts on heritage resources identified above (see section 4.2.1.4 Resource 4: Heritage Resources) for the proposed action would not occur. These resources would continue to be subject primarily to the forces of nature (e.g., floods and earthquakes) and ongoing recreational use with its associated potential for looting or inadvertent damage.

4.3 Cumulative Impacts Analysis

"Cumulative impacts" are those impacts resulting from the incremental impact of an action when added to other past, present, or reasonably foreseeable actions regardless of what agency or person undertakes such other actions. Because the proposed action would involve underground mining with no surface development, all direct and indirect impacts would be associated with subsidence and would affect only the lease modification areas themselves. As a result, the cumulative effects analysis area is confined to the lease modification areas.

4.3.1 Past and Present Actions

Past or ongoing actions that could affect the same components of the environment as the proposed action are operation of the SUFCO Mine to date, grazing occurring on the lease modification areas under Forest Service permit, and recreational use.

Operations at SUFCO Mine began in 1941 as a small local operation extracting coal underground from the original federal coal lease SL-062583. Production has increased over time since coal was first used for local community needs until today when the mine provides large-scale supply for western power plant fuel needs. Since the 1970s when the mine was sold to a large energy company, more leases have been acquired, more people employed, and more efficient technology adopted. Mining methods have changed from room-and-pillar methods with conventional blasting of the coal face to high-tech longwall mining machines.

Current production is about 7 million tons per year, from seven federal and one state lease tracts totaling over 24,000 acres. The mine portal lies in Convulsion Canyon, approximately 30 miles east of Salina, Sevier County, Utah. The mine is accessed by a 12-mile county road off of Interstate 70. Current employment is about 350, most of whom live in surrounding communities in Sevier County.

Livestock grazing has occurred on the modification areas since the late 1800s, and the lease modification areas are currently grazed under Forest Service permit as part of the 27,985-acre Quitchumpah Cattle and Horse Allotment. According to the Allotment Management Plan (AMP; Forest Service 1977, as amended), the allotment is under "Intensive management for environment and livestock."

Six operators are included in the grazing permit. Cattle are the permitted livestock type, with 820 cow/calf pairs allowed on the entire allotment. The grazing season begins June 11 and ends September 30 but may be shortened if forage utilization limits (50 percent of key species, which are wheatgrasses) are met earlier.

A four-pasture rest-rotation grazing system has been employed for many years, under which any given area receives each of the following treatments one year in four: complete rest, season-long grazing, grazing after flowering of key species, and grazing after seed-ripe of key species. Both long-term and current trends in range condition are stable or upward. No needs for changes in grazing management have been identified.

Stockwater is a key aspect of management of the allotment and the lease modification areas for grazing. As discussed above (see section 3.3.1.1, Surface Water Resources), troughs and ponds fed by runoff or springs have been developed in Duncan, Mud Spring, and Pin hollows (Figure 3-1).

The modification areas also support light levels of recreational use. There are no developed facilities, and they are not part of the more popular hunting units in the region. Use is largely by recreationists using the roads that traverse the area, seeing the sights or accessing adjacent areas.

4.3.2 Reasonably Foreseeable Action Scenario (RFAS)

The following RFAS identifies reasonably foreseeable future actions that could cumulatively affect the same resources in the cumulative impact area as the proposed action and alternatives.

In terms of the lease modification areas themselves, no change beyond potential surface exploration activities and the continued grazing use described above is anticipated. Beyond that, future development of the SUFCO Mine has been considered in this RFAS. That development could entail continued mining of currently leased tracts (e.g., Quitchupah), tracts proposed for leasing and currently being reviewed (e.g., Greens Hollow), and tracts under consideration but not yet proposed for leasing (e.g., Utah School and Institutional Trust Lands Administration [SITLA] lands). While such development would not involve the proposed lease modification tracts, they would affect the overall scope and operation of the SUFCO Mine and could potentially impact the lease modification areas indirectly.

4.3.3 Cumulative Impacts

It has been determined that cumulative impacts would be negligible as a result of the proposed action or alternatives because:

- The direct and indirect effects of the proposed action on surface resources would be minimal, as discussed above, and associated primarily with subsidence. This limits the types of impacts which can be added to them in a meaningful, cumulative way.

- While Ark may request authorization for coal exploration (e.g., drilling or other methods) on the modification areas if a lease is issued, potential exploration activities have not been identified (see section 2.2, Alternative A – Proposed Action) and their effects cannot be assessed at this time. At such time as an exploration plan is developed and submitted, it will subject to NEPA review prior to approval. Adequate information to assess cumulative effects will be available at that time.

- Ongoing grazing management is not anticipated to change, and its effects on lease modification area resources are unrelated in nature to the subsidence-generated impacts potentially occurring as a result of the proposed action or alternatives. Therefore, grazing effects are not additive in a cumulative sense.

- Operation of the SUFCO Mine to date has had no discernable effect on the resources of the lease modification areas. As a result, current operations have no apparent impact to which the proposed action or alternatives would add in a cumulative manner.

- Similarly, future development of the SUFCO Mine through additional leases should have no cumulative effect. Development of adjacent areas such as the current Quitchupah Tract have not affected the lease modification areas to date and are not anticipated to in the future. Other areas of possible development such as Greens Hollow and SITLA lands are separated by substantial distances of intervening terrain and have no apparent connection in terms of hydrology or other relevant resources. Further, each future development area considered in this analysis has its own independent utility and would be pursued independently, regardless of the ultimate disposition of other potential developments.

5.0 CONSULTATION AND COORDINATION:

5.1 Introduction

The issue identification section of Chapter 1 identifies those issues analyzed in detail in Chapter 4. Appendix A provides the rationale for issues that were considered but not analyzed further. The issues were identified through the public and agency involvement process described in sections 5.2 and 5.3 below.

5.2 Persons, Groups, and Agencies Consulted

Table 5-1 identifies the people, groups, and agencies consulted in the preparation of this EA.

Table 5-1. Persons, agencies, and organizations consulted.

Name	Purpose & Authorities for Consultation or Coordination	Findings & Conclusions
USDA-Forest Service, Fishlake National Forest	Consultation in accordance with BLM regulations regarding coal lease modifications (43 CFR 3432[3][d]), particularly protection of non-mineral natural resources managed by the Forest Service.	Fishlake National Forest must consent, in writing, with the findings documented in this EA before the lease modifications can occur. Their resource specialists also took the lead in the internal review to identify issues to be addressed in the EA (Appendix A) and reviewed the EA, as the Forest is responsible for management of surface resources in the modification areas.
Utah State Historic Preservation Office (SHPO)	Consultation on federal agency undertakings, as required by the National Historic Preservation Act (NHPA; 16 USC 470)	SHPO will concur with the findings of the heritage resource report prepared for this proposed action prior to issuance of a decision.
Native American Tribes	Consultation on federal agency undertakings, as required by the NHPA and Executive Order 13007.	Eight Tribes were consulted, and two (the Paiute Indian Tribe of Utah, in Cedar City, and the Northern Ute, in Fort Duchesne) expressed any interest in the proposal. They subsequently concluded that the modification areas include no historic properties of religious or cultural significance.

5.3 Summary of Public Participation

Issues to be addressed in this EA were identified in two ways, through a scoping exercise inviting comment from the public and from other agencies, and through standard, internal, interdisciplinary review of the proposal.

Scoping was conducted primarily by the Fishlake National Forest. A legal notice of the proposed action was published June 11, 2008, in the newspaper of record, the Richfield Reaper, initiating a 30-day scoping period. The notice was also posted on the Forest website's quarterly Schedule of Proposed Actions. One comment letter was received, and it cited several concerns.

Notice of the proposed action was also posted on the BLM's Environmental Notification Bulletin Board (ENBB) on July 29, 2008. No comments were generated.

A scoping report, including the legal notice, the comment letter, and a discussion of how each comment affects the scope of the analysis was prepared and included in the project record.

The results of the internal review are documented in the BLM's standard Interdisciplinary Team Analysis Record Checklist, which is attached as Appendix A. The review included consideration of the Critical Elements of the Human Environment. These elements are specified in statute, regulation, or executive order, and must be considered in all EAs.

The internal review covered all substantive issues raised by the scoping commenter. The checklist identified the resource areas with the potential for significant impact, warranting detailed analysis in this EA.

The completed EA was released for comment during a 30-day period prior to issuance of a decision. A notice of availability was posted on the ENBB, and copies of the EA were sent to those who submitted scoping comments. Depending on the nature of the comments received on the pre-decisional EA, either a comment report summarizing and responding to comments will be prepared and included in the project record, or the EA will be revised as appropriate and re-released with the decision.

5.4 List of Preparers

Tables 5-2 through 5-4 list the BLM, Forest Service, and contractor preparers of this EA, respectively.

Table 5-2. BLM preparers.

Name	Title	Responsible for the Following Section(s) of this Document
Steve Falk	Team Leader	Project management, coordination, and quality control.
Steve Rigby	Senior Mining Engineer	Technical oversight and coordination.
Jeff McKenzie	Branch Chief, Solid Minerals (Acting)	Technical oversight and coordination.
Mike Glasson	Geologist	Technical oversight and coordination.
Jim Kohler	Branch Chief, Solid Minerals (Retired)	Technical oversight and coordination.
Floyd Johnson	Environmental Coordinator	NEPA review and oversight.

Table 5-3. Forest Service preparers.		
Name	**Title**	**Responsible for the Following Section(s) of this Document**
Chris Wehrli	Forest Service Project Leader	Coordination with Fishlake National Forest and quality control.
Fred Houston	District Ranger	Line officer review and concurrence.
Adam Solt	Hydrologist	Review of surface and ground water analysis.
Bob Tuttle	Range Conservationist	Review of livestock grazing analysis.
Chris Colt	Wildlife Biologist	Review of wildlife analysis.
Bob Leonard	Archaeologist	Review of heritage resource analysis.

Table 5-4. Contractor preparers.		
Name	**Title**	**Responsible for the Following Section(s) of this Document**
Cirrus Ecological Solutions, LC		
Scott Evans	Project Coordinator	Coordination and quality control.
Neal Artz	Project Manager	EA process management, technical writing, and production.
Eric Duffin	Watershed Hydrologist	Technical analysis of surface and ground water resource issue.
John Stewart	Wetland Specialist	Technical analysis of wetland issue.
Tom Ashton	Wildlife Biologist	Technical analysis of wildlife issue.
Western Land Services		
Colin Ferriman	Archaeologist	Technical analysis of heritage resource issue.

6.0 REFERENCES

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APPENDIX A:
Interdisciplinary Team Analysis Record Checklist

RECEIVED

eld BLM Field Office

Project Title: West Coal Lease Modifications Environmental Assessment

NEPA Log Number: UT-070-08-083

File/Serial Number:

Project Leader: Stephen Falk

DETERMINATION OF STAFF: (Choose one of the following abbreviated options for the left column)

NP = not present in the area impacted by the proposed or alternative actions
NI = present, but not affected to a degree that detailed analysis is required
PI = present with potential for significant impact analyzed in detail in the EA; or identified in a DNA as requiring further analysis
NC = (DNAs only) actions and impacts not changed from those disclosed in the existing NEPA documents cited in Section C of the DNA form.

Determination*	Resource	Rationale for Determination**	Signature	Date
		CRITICAL ELEMENTS		
NI *(BLM)*	Air Quality	The project area lies in a Class II airshed. Current operating facilities would not be expanded but would be extended. No new air pollutant sources would occur. Potential impacts beyond current permits would be limited to subsidence. Proposal is not anticipated to affect air quality.	[illegible]	12/9/08
NP *(BLM)*	Areas of Critical Environmental Concern	There are no ACECs present near the project area.	[illegible]	12/9/08
PI *(FS)*	Cultural Resources	Surface impact limited to subsidence. Areas of concern include potential rockfall and surface cracking.	[illegible]	11/18/08
NI *(BLM)*	Environmental Justice	There are no affected groups, minority or low income, disproportionately affected.	[illegible]	12/9/08
NP *(BLM)*	Farmlands (Prime or Unique)	There are no farmlands (prime or unique) within the project area.	[illegible]	12/9/08
NI *(BLM)*	Floodplains	None of the alternatives or proposals involve actions that would result in fills or diversions or placement of permanent facilities in flood plains. They thus comply with Executive Order 11988.	[illegible]	11/18/08
NP *(FS)*	Invasive, Non-native Species	The proposed project involves no surface disturbance or other activities that would have the potential to introduce invasive or non-native species.	[illegible]	11/19/08
NI *(BLM)*	Native American Religious Concerns	Only two tribes expressed any interest in this proposal. No religious issues were identified.	Craig Harmon	12/4/08
NP *(FS)*	Threatened, Endangered or Candidate Plant Species	Project area is outside of the elevational range, geographical range, and/or habitat constraints of any Threatened, Endangered, or Candidate plant species.	C. Colt	11/18/08
NP *(FS)*	Threatened, Endangered or Candidate Animal Species	No Threatened, Endangered, or Candidate animal species have been documented in the project area.	C. Colt	11/18/08
NI *(FS)*	Wastes (hazardous or solid)	The project would not generate any hazardous or solid waste.	[illegible]	11/20/08

Determi-nation*	Resource	Rationale for Determination**	Signature	Date
PI *(FS)*	Water Quality (drinking/ground)	Water features in the project area include ephemeral, runoff flows in Duncan Draw, Mud Spring Hollow, Pin Hollow, and Broad Hollow as well as seeps and springs in some of these drainages. Subsidence could impact the quality and hydrology of these surface waters and groundwater, and such impacts could have broader effects on the project area's ecosystem. As the project area is not part of any municipal watershed, potential drinking water impacts are not a concern.	[illegible]	11/18/08
PI *(FS)*	Wetlands/Riparian Zones	Small, discrete wetlands occur in the project area. Isolated occurrences of wetland/riparian zones may be associated with Duncan Draw, Mud Spring Hollow, Pin Hollow, and Broad Hollow. Any impacts on surface or groundwater quality or hydrology could affect these aquatic ecosystems.	[illegible]	11/18/08
NP *(FS)*	Wild and Scenic Rivers	Wild and Scenic Rivers do not occur in the project area.	[illegible]	11/20/08
NP *(FS)*	Wilderness	The project area does not include any designated or proposed wilderness.	[illegible]	11/20/08
		OTHER RESOURCES / CONCERNS		
NI *(FS)*	Rangeland Health Standards and Guidelines	The project will have little to no impact on rangeland health standards and guidelines.	[illegible]	11/20/08
NI *(FS)*	Livestock Grazing	Grazing in the mining area is cow/calf pairs (813 head). Several water developments (Mud Spring Trough, Middle Mud Spring Trough, Lower Mud Spring Trough, and Middle Duncan Draw Trough), are known to occur in the project area. Damage to water developments from subsidence would restrict grazing use of the area. However, there is 700 to 1,000 feet of overburden below these springs, so the risk of subsidence damage is slight. If these water developments are damaged, mitigation would be required for livestock watering.	Bob Tuttle	11/18/08
NI *(FS)*	Vegetation including Special Status Plant Species other than FWS candidate or listed species	The project area contains potential habitat for special status plant species. However, a reconnaissance survey of the project area was completed to assess habitat and likelihood of species occurrence. No individuals of special status species were found, and subsidence would be unlikely to affect potential habitats if Castlegate outcrops are not subsided.	[illegible]	11/19/08
PI *(FS)*	Fish and Wildlife Including Special Status Species other than FWS candidate or listed species e.g. Migratory birds.	Several Forest Service sensitive species and other special status species such as management indicator species (MIS) and migratory birds potentially occur in the project area and could be affected indirectly by subsidence.	[illegible]	11/18/08
NI *(FS)*	Recreation	Recreation use of the project area is limited. Potential impacts of subsidence may occur to FR006, FR007, FR010, FR267, FR1401, FR1402, and FR1404. All roads would be re-habilitated as part of this proposal, so any impacts would be temporary. Recreational users may experience temporary road closures and decreases in recreational values as repairs are made.	[illegible]	11/20/08
NI *(FS)*	Paleontology	Impacts on paleontological resources are not anticipated. The proposed operations would create minimal to negligible surface disturbances. Buried resources may be affected. Required mitigation (cessation of work and notification of agency archaeologists) would avoid impacts on any buried resources encountered during development.	[illegible]	11/18/08

Determination*	Resource	Rationale for Determination**	Signature	Date
NP *(FS)*	Fuels / Fire Management	There would be no impact on fire/fuels.	[illegible]	11/20/08
NP *(BLM)*	Wild Horses and Burros	Proposed project does not occur within or adjacent to any wild horse HMAs.	[illegible]	12/4/08
NP *(BLM)*	Wilderness characteristics	Project as proposed is not within or adjacent to any WSAs.		
NI *(FS)*	Other: Roadless	A portion of the project area is located in the White Mountain Inventoried Roadless Area. No additional roads are proposed as part of this project and the project would not decrease the roadless area values in the project area.	[illegible]	11/20/08
	Other:			

** Agency making the determination identified in parenthesis (i.e., Bureau of Land Management or Forest Service).*
*** Rationale for Determination is required for all "NIs" and "NPs." Write issue statements for "PIs"*

FINAL REVIEW:
Bureau of Land Management

Reviewer Title	Signature	Date	Comments
NEPA / Environmental Coordinator	[illegible]	12/4/08	
Authorized Officer			

Forest Service

Reviewer Title	Signature	Date	Comments
NEPA / Environmental Coordinator	[illegible]	11-20-08	All National Forest Resource Issues Covered
Authorized Officer	[illegible]	11/21/08	

APPENDIX B:

FISHLAKE NATIONAL FOREST
COAL LEASE
SPECIAL STIPULATIONS

The Mineral Leasing Act (MLA) provides that the Secretary of the Interior may only lease coal under National Forest System lands upon consent of the Forest Service and upon such conditions as the Forest Service may prescribe with respect to the use and protection of the non-mineral interests in those lands. 30 U.S.C. § 201(a)(3)(A)(iii); 43 CFR 3400.3-1. All or part of this lease encompasses lands which are part of the National Forest System and administered by the United States Department of Agriculture, Forest Service, Fishlake National Forest. As a condition of consenting to this lease the Forest Service is requiring that the lease contain the following stipulations governing operations that affect the surface of National Forest System lands within the lease area and that all operations are conducted in accordance with the following stipulations:

Forest Service Stipulation #1

Before undertaking activities that may disturb the surface of National Forest System lands, the Lessee is required to conduct a cultural resource inventory and a paleontological appraisal of the areas to be disturbed. This inventory and appraisal shall be conducted by qualified professional cultural resource specialists or qualified paleontologists, as appropriate, and a report prepared itemizing the findings, together with a plan making recommendations for the protection of, or measures to be taken to mitigate impacts for identified cultural or paleontological resources. No surface disturbance may occur until the report and recommendations for protection have been approved by the Forest Service.

If cultural resources or paleontological remains (fossils) of significant scientific interest are discovered during operations under this lease the Lessee shall immediately bring them to the attention of the appropriate authority. The Lessee shall avoid further disturbance of such cultural resources or paleontological remains discovered during operations under this lease until a plan making recommendations for the protection of, or measures to be taken to mitigate impacts for identified cultural or paleontological resources is approved by the Forest Service. Operations may then proceed in accordance with this approved plan. Paleontological remains of significant scientific interest do not include leaves, ferns or dinosaur tracks commonly encountered during underground mining operations.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the Lessee.

Forest Service Stipulation #2

If there is reason to believe that Threatened or Endangered (T&E) species of plants or animals, or migratory bird species of high Federal interest occur in the area, the Lessee shall conduct an intensive field inventory of the surface area to be disturbed and/or impacted by mining operations. The inventory shall be conducted by a qualified specialist and a report of findings will be prepared. The Lessee shall prepare a plan making recommendations for the protection of these species or action necessary to mitigate the disturbance, which must be approved by the

Forest Service prior to proceeding with operations that may cause surface disturbance which will impact T&E species or their habitat. All operations shall be conducted in accordance with this approved plan.

The cost of conducting the inventory, preparing reports and carrying out mitigating measures shall be borne by the Lessee.

Forest Service Stipulation #3
The Lessee shall perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. Existing data may be used if such data are adequate for the intended purposes. The study shall be adequate to locate, quantify, and demonstrate the interrelationship of the geology, topography, surface and ground water hydrology, vegetation and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison. This study must be approved by the Forest Service before any operations which cause surface disturbance may proceed.

Forest Service Stipulation #4
Surface powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to provide adequate protection for raptors and other large birds. When feasible, surface powerlines will be buried in accordance with existing electrical codes.

Forest Service Stipulation #5
The limited area available for mine facilities at the coal outcrop, steep topography, adverse winter weather, and physical limitations on the size and design of access roads are factors which will determine the ultimate size of the surface area utilized for facilities necessary for the mine. A site-specific environmental analysis will be prepared for each new mine site development and for major improvements to existing developments to examine alternatives and mitigate conflicts. No surface facilities will be constructed or major improvements made to existing facilities without express written prior Forest Service concurrence or approval.

Forest Service Stipulation #6
Consideration will be given to site selection to reduce adverse visual impacts. Where alternative sites are available, and each alternative is technically feasible, the alternative involving the least damage to the scenery and other resources shall be selected. Permanent structures and facilities will be designed, and screening techniques employed to reduce visual impacts and, where possible, achieve a final landscape compatible with the natural surroundings. The creation of unusual, objectionable, or unnatural landforms and vegetative landscape features will be avoided.

Forest Service Stipulation #7
The Lessee shall establish a monitoring system to locate, measure and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the lease area. The monitoring shall incorporate and be an extension of the baseline data. The monitoring system must be approved by the Forest Service prior to commencement of mining operations which affect surface resources.

Forest Service Stipulation #8
The Lessee shall provide for the suppression and control of fugitive dust on haul roads and at coal handling and storage facilities. On Forest Development Roads (FDR), where there is a significant

amount of traffic that is not related to mining activities, Lessee will be required to perform maintenance commensurate with their proportional use of the FDR in accordance with 36 CFR § 212.9.

Forest Service Stipulation #9
Except at locations specifically approved by the Authorized Officer, with the concurrence of the Forest Service, underground mining operations shall be conducted in such a manner so as to prevent surface subsidence that would: (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides, (2) cause damage to existing surface structures, and (3) damage or alter the flow of perennial streams. Where the Forest Service specifically approves exceptions to the above restrictions on subsidence, the Lessee shall provide specific measures for the protection of escarpments, and determine corrective measures to assure that hazardous conditions are not created.

Forest Service Stipulation #10
In order to avoid surface disturbance on steep canyon slopes and to preclude the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specific locations approved by the Forest Service.

Forest Service Stipulation #11
If removal of timber is required for clearing of construction sites, etc., such timber shall be removed and disposed of only in accordance with the regulations of the Secretary of Agriculture.

Forest Service Stipulation #12
The coal contained within, and authorized for mining under this lease shall be extracted only by underground mining methods.

Forest Service Stipulation #13
Existing permitted surface improvements operated, permitted, or administered by the Forest Service shall be protected by the Lessee during mining operations. Any such improvements damaged or destroyed by mining operations shall be restored or replaced by the Lessee as directed by the Forest Service.

Forest Service Stipulation #14
In order to protect big-game wintering areas, elk calving and deer fawning areas, sagegrouse strutting areas, and other key wildlife habitat and/or activities, specific surface uses outside the mine development area may be curtailed by the Forest Service during specified periods of the year.

Forest Service Stipulation #15
Support facilities, structures, equipment, and similar developments on National Forest System lands within the Lease area will be removed by the Lessee within two years after the final termination of use of such facilities. This provision shall apply unless the requirement of Section 10 of the lease form is applicable. Disturbed areas and those areas previously occupied by such facilities will be stabilized and rehabilitated as directed by the Forest Service, including re-establishment of drainages and return of the surface areas to pre-mining land use.

Forest Service Stipulation #16
The Lessee, at the conclusion of the mining operation, or at other times as surface disturbance related to mining may occur, will replace all damaged, disturbed or displaced corner monuments

(section corners, 1/4 corners, etc.), their accessories and appendages (witness trees, bearing trees, etc.), or restore them to their original condition and location, or at other locations that meet the requirements of the rectangular surveying system. This work shall be conducted at the expense of the Lessee, by Bureau of Land Management (BLM) land surveyors to the standards and guidelines found in the Manual of Surveying Instructions, United States Department of the Interior.

Forest Service Stipulation #17

The Lesseee, at their expense, shall replace any surface and/or developed groundwater sources identified for protection that may be lost or adversely affected by mining operations with water from an alternate source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, livestock and wildlife use, or other land uses.

Forest Service Stipulation #18

ABANDONMENT OF EQUIPMENT:

The Lessee/Operator is responsible for compliance and reporting regarding toxic and hazardous material and substances under Federal Law and all associated amendments and regulations for the handling of such materials on the land surface and in underground mine workings.

The Lessee/Operator must remove mine equipment and materials not needed for continued operations, roof support and mine safety from underground workings prior to abandonment of mine sections. Exceptions can be approved by the Forest Service. Any on-site disposal of non-coal waste must comply with 30 CFR § 817.89 and must be approved by the regulatory authority responsible for the enforcement of the Surface Mining Control and Reclamation Act (30 U.S.C. 1201, et seq.). Creation of a situation that would prevent removal of such material and equipment by retreat or abandonment of mine sections, without prior authorization would be considered noncompliance with lease terms and conditions and subject to appropriate penalties under the lease.

All safe and accessible areas shall be inspected prior to being sealed. The Lessee shall notify the Authorized Officer in writing 30 days prior to the sealing of any areas in the mine and state the reason for closure. Prior to seals being put into place, the Lessee shall inspect the area and certify through documentation any equipment/machinery, hazardous substances, and used oil that is intended to be left underground. The Authorized Officer may participate in this inspection. The purpose of this inspection will be: (1) to provide documentation for compliance with 42 U.S.C. 9620 section 120 (h) and State Management Rule R-315-15, and to assure that certification will be meaningful at the time of lease relinquishment, (2) to document the inspection with a mine map showing location of equipment/machinery (model, type of fluid, amount remaining, batteries, etc.) that is proposed to be left underground. In addition, these items will be photographed at the Lessee's expense and shall be submitted to the Authorized Officer as part of the certification.

WASTE CERTIFICATION:

The Lessee shall provide on a yearly basis and prior to lease relinquishment, certification to the Lessor that, based upon a complete search of all the Operator's records for the mine and upon their knowledge of past operations, there has been no hazardous substances defined as per 40 CFR 302.4 or used oil as per Utah State Management Rule R-315-15, deposited within the lease, either on the surface or underground, or that all remedial action necessary has been taken to protect human health and the environment with respect to any such substances remaining on the property. The back-up documentation to be provided shall be described by the Lessor prior to the first certification and shall include all documentation applicable to the Emergency Planning and

Community Right-to-know Act (EPCRA, Public Law 99-499), Title III of the Superfund Amendments and Reauthorization Act of 1986 or equivalent.

Forest Service Stipulation #19
The Licensee/Permittee/Lessee must comply with all the rules and regulations of the Secretary of Agriculture set forth at Title 36, Chapter II, of the Code of Federal Regulations governing the use and management of the National Forest System (NFS).
All matters related to this stipulation are to be addressed to:

Forest Supervisor
Fishlake National Forest
115 East 900 North
Richfield, Utah 84701

Telephone Number: 435-896-9233

who is the authorized representative of the Forest Service and the Secretary of Agriculture.

____
Signature
Licensee/Permittee/Lessee

APPENDIX C.

Species of Concern List for Bird Conservation Region 16.

BCR 16 (Southern Rockies/Colorado Plateau) BCC 2002 List.

Northern Harrier
Swainson's Hawk
Ferruginous Hawk
Golden Eagle
Peregrine Falcon
Prairie Falcon
Gunnison Sage-grouse
Snowy Plover
Mountain Plover
Solitary Sandpiper
Marbled Godwit
Wilson's Phalarope
Yellow-billed Cuckoo
Flammulated Owl
Burrowing Owl
Short-eared Owl
Black Swift
Lewis's Woodpecker
Williamson's Sapsucker
Gray Vireo
Pinyon Jay
Bendire's Thrasher
Crissal Thrasher
Sprague's Pipit
Virginia's Warbler
Black-throated Gray Warbler
Grace's Warbler
Sage Sparrow
Chestnut-collared Longspur

APPENDIX 7-1

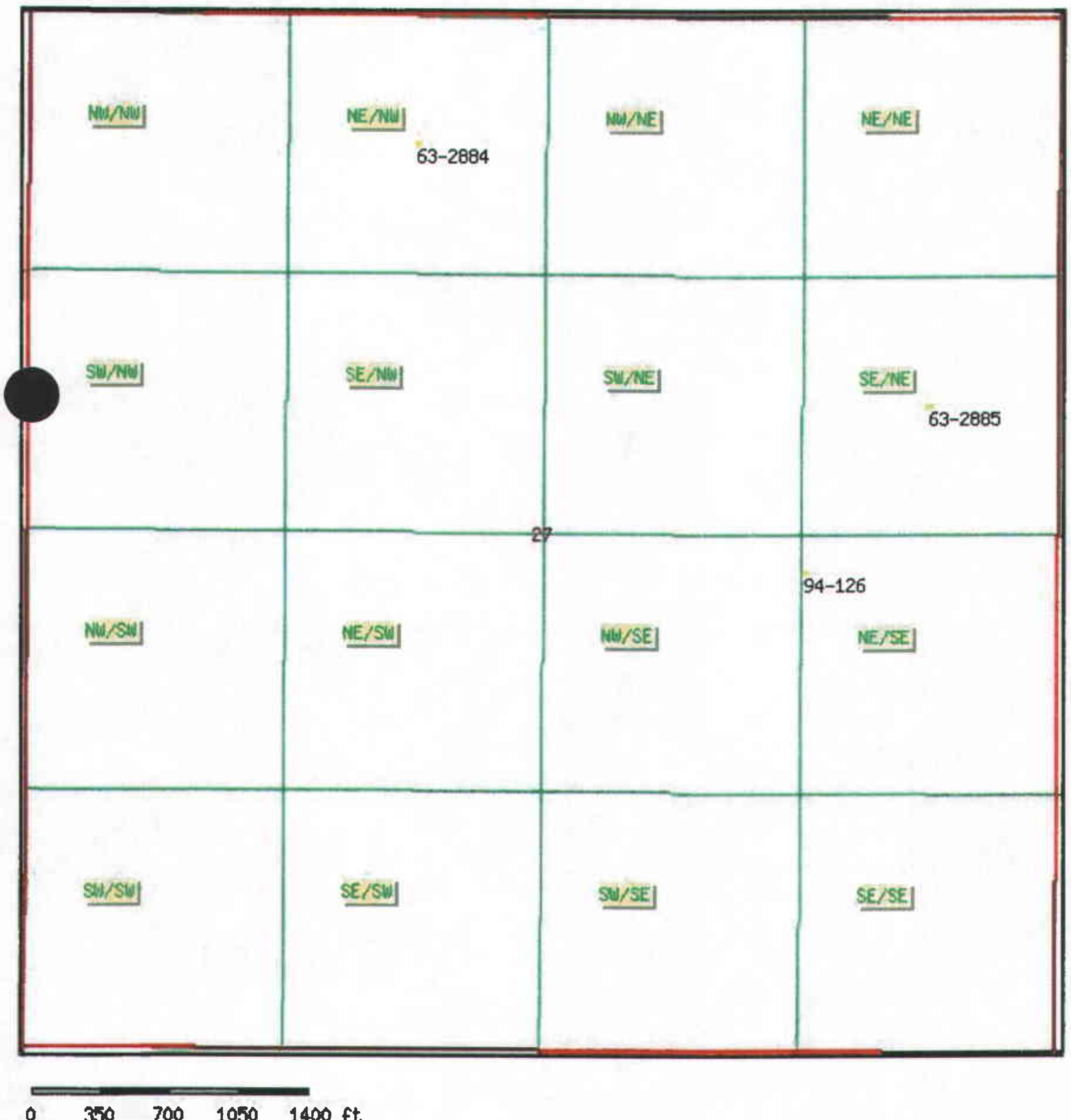
Water Rights Data

Utah Division of Water Rights

Output Listing

Version: 2009.05.06.00 **Rundate: 06/08/2010 09:22 AM**

Search of Section 27, Township 21S, Range 4E, SL b&m Criteria:wrtypes=W,C,E podtypes=S,U,D,Sp, P,R,T status=A,P usetypes=all



Water Rights

WR Number	Diversion Type/Location	Well Log	Status	Priority	Uses	CFS	ACFT	Owner Name
63-2884	Point to Point S660 W660 N4 27 21S 4E SL		P	18930000	OS	0.015	0.000	USA FOREST SERVICE 324 25TH STREET
63-2885	Point to Point N660 W660 E4 27 21S 4E SL		P	18930000	OS	0.015	0.000	USA FOREST SERVICE 324 25TH STREET
94-126	Spring N2450 W1280 SE 27 21S 4E SL		P	18790000	OS	0.015	0.000	USA FOREST SERVICE 324 - 25TH STREET

STATE OF UTAH -- DIVISION OF WATER RIGHTS -- DATA PRINT OUT for 94-126

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 94-126 APPLICATION/CLAIM NO.: CERT. NO.:

CHANGES: a35187 Approved

OWNERSHIP

NAME: USA Forest Service
ADDR: 324 - 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? COUNTY TAX ID#:

FILED:	PRIORITY: 00/00/1879	PUB BEGAN:	PUB ENDED:	NEWSPAPER:	
ProtestEnd:	PROTESTED: [No]	HEARNG HLD:	SE ACTION: [ ]	ActionDate:	PROOF DUE:
EXTENSION:	ELEC/PROOF: [ ]	ELEC/PROOF:	CERT/WUC:	LAP, ETC:	LAPS LETTER:
RUSH LETTR:	RENOVATE:	RECON REQ:	TYPE: [ ]		

PD BOOK: [94-1] | MAP: [ ] | PUB DATE:

Type of Right: Diligence Claim Source of Info: Proposed Determination Status:

LOCATION OF WATER RIGHT

FLOW: 0.015 cfs SOURCE: Mud Spring (001-020)

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF SPRING:
(1) N 2450 ft W 1280 ft from SE cor, Sec 27, T 21S, R 4E, SLBM
Diverting Works: Source:

USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family

SUPPLEMENTAL GROUP NO. 425880. Water Rights Appurtenant to the following use(s):
63-2685(DIL),2710(DIL),2711(DIL),2725(DIL),2726(DIL),2742(DIL),2743(DIL),2772(DIL),2773(DIL),3361(DIL),3362(DIL),3363(DIL)
3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL),3373(DIL),3374(DIL),3375(DIL),3376(DIL)
3377(DIL),3378(DIL),3379(DIL),3380(DIL),3381(DIL),3382(DIL),3383(DIL),3384(DIL),3385(DIL),3386(DIL),3387(DIL),3388(DIL),3389(DIL)
3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL),3399(DIL),3400(DIL),3401(DIL),3402(DIL)
3403(DIL),3404(DIL),3405(DIL),3406(DIL),3407(DIL),3408(DIL),3409(DIL),3410(DIL),3494(DIL),3495(DIL),3496(DIL),3497(DIL),3498(DIL)
3499(DIL),3500(DIL),3501(DIL),3502(DIL),3503(DIL),3504(DIL),3505(DIL),3506(DIL),3507(DIL),3508(DIL),3509(DIL),3510(DIL),3511(DIL)
3512(DIL),3513(DIL),3514(DIL),3515(DIL),3516(DIL),3517(DIL),3518(DIL),3519(DIL),3520(DIL),3521(DIL),3522(DIL),3523(DIL),3524(DIL)
3525(DIL),3526(DIL),3527(DIL),3528(DIL),3529(DIL),3530(DIL),3531(DIL),3532(DIL),3533(DIL),3534(DIL),3535(DIL),3536(DIL),3537(DIL)
3538(DIL),3539(DIL),3540(DIL),94-110(DIL),111(DIL),112(DIL),113(DIL),114(DIL),115(DIL),116(DIL),117(DIL),118(DIL),119(DIL)
120(DIL),121(DIL),122(DIL),123(DIL),124(DIL),125(DIL),126(DIL),127(DIL),128(DIL),129(DIL),130(DIL),131(DIL),132(DIL),133(DIL)
134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC),1387(WUC),1388(WUC),1389(WUC)
1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC),1400(WUC),1401(WUC),1402(WUC)
1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC),1413(WUC),1414(WUC),1415(WUC)
1593(WUC),1594(WUC)

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 819.0000 Div Limit: PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

WILDLIFE: 1270 deer & 115 elk PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated
Quitchumpah Allotment

SUPPLEMENTAL GROUP NO. 617789. Water Rights Appurtenant to the following use(s):
63-3361(DIL),3362(DIL),3363(DIL),3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL)
3373(DIL),3374(DIL),3375(DIL),3376(DIL),3377(DIL),3378(DIL),3379(DIL),3380(DIL),3381(DIL),3382(DIL),3383(DIL),3384(DIL),3385(DIL)
3386(DIL),3387(DIL),3388(DIL),3389(DIL),3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL)
3399(DIL),3400(DIL),3401(DIL),3402(DIL),3403(DIL),3404(DIL),3405(DIL),3406(DIL),3407(DIL),3408(DIL),3409(DIL),3410(DIL),3494(DIL)
3495(DIL),3496(DIL),3497(DIL),3498(DIL),3499(DIL),3500(DIL),3501(DIL),3502(DIL),3503(DIL),3504(DIL),3505(DIL),3506(DIL),3507(DIL)

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116(DIL),117(DIL),118(DIL),119(DIL),120(DIL),121(DIL),122(DIL),123(DIL),124(DIL),125(DIL),126(DIL),127(DIL),128(DIL),129(DIL)
130(DIL),131(DIL),132(DIL),133(DIL),134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC)
1387(WUC),1388(WUC),1389(WUC),1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC)
1400(WUC),1401(WUC),1402(WUC),1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC)
1413(WUC),1414(WUC),1415(WUC),1593(WUC),1594(WUC)

STOCKWATER: Sole Supply: 14.0000 ELUs of the Group Total of 81.0000 Div Limit: 12.70356 acft. PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

PLACE OF USE for STOCKWATERING

	NORTH-WEST¼ NW NE SW SE	NORTH-EAST¼ NW NE SW SE	SOUTH-WEST¼ NW NE SW SE	SOUTH-EAST¼ NW NE SW SE
Sec 27 T 21S R 4E SLBM	* : : : *	* : : : *	* : : : *	* X: : : *

OTHER COMMENTS

Map: Acord Lakes

E N D O F D A T A

STATE OF UTAH – DIVISION OF WATER RIGHTS – DATA PRINT OUT for 63-2884(D4422)

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 63-2884 APPLICATION/CLAIM NO.: D4422 CERT. NO.:

OWNERSHIP

NAME: USA Forest Service
ADDR: 324 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: 04/17/1985 | PRIORITY: 00/00/1893 | PUB BEGAN: | PUB ENDED: | NEWSPAPER:
ProtestEnd: | PROTESTED: [No] | HEARNG HLD: | SE ACTION: [ ] | ActionDate: | PROOF DUE:
EXTENSION: | ELEC/PROOF: [ ] | ELEC/PROOF: | CERT/WUC: | LAP, ETC: | LAPS LETTER:
RUSH LETTR: | RENOVATE: | RECON REQ: | TYPE: [ ]

PD BOOK: [63-] | MAP: [614] | PUB DATE:

Type of Right: Diligence Claim Source of Info: Diligence Claim Status:

LOCATION OF WATER RIGHT

FLOW: 0.015 cfs SOURCE: Bog Hole Spring

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF DIVERSION:
(1)Stockwatering directly on spring located at S 660 ft. W 660 ft. from N4 corner, Sec 27, T21S, R4E, SLBM.
COMMENT: Administratively updated by State Engineer.

USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family

SUPPLEMENTAL GROUP NO. 426084.

STOCKWATER: 819.0000 Stock Units Div Limit: PERIOD OF USE: 05/01 TO 11/30

WILDLIFE: PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated

PLACE OF USE for STOCKWATERING

	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 27 T 21S R 4E SLBM	* : X: : *	* : : : *	* : : : *	* : : : *

OTHER COMMENTS

Quitchumpah Allotment

E N D O F D A T A

STATE OF UTAH – DIVISION OF WATER RIGHTS – DATA PRINT OUT for 63-2885(D4423)

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 63-2885 APPLICATION/CLAIM NO.: D4423 CERT. NO.:

OWNERSHIP

NAME: USA Forest Service
ADDR: 324 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: 04/17/1985 |PRIORITY: 00/00/1893 |PUB BEGAN: |PUB ENDED: |NEWSPAPER:
ProtestEnd: |PROTESTED: [No] |HEARNG HLD: |SE ACTION: [ ] |ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF: [ ] |ELEC/PROOF: |CERT/WUC: |LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]

PD BOOK: [63-] |MAP: [615] |PUB DATE:

Type of Right: Diligence Claim Source of Info: Diligence Claim Status:

LOCATION OF WATER RIGHT

FLOW: 0.015 cfs SOURCE: Steed Draw Spring

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF DIVERSION:
(1)Stockwatering directly on spring located at N 660 ft. W 660 ft. from E4 corner, Sec 27, T21S, R4E, SLBM.
COMMENT: Administratively updated by State Engineer.

USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family

SUPPLEMENTAL GROUP NO. 426085.

STOCKWATER: 819.0000 Stock Units Div Limit: PERIOD OF USE: 05/01 TO 11/30

WILDLIFE: PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated

PLACE OF USE for STOCKWATERING

	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 27 T 21S R 4E SLBM	* : : : *	* : : : X*	* : : : *	* : : : *

OTHER COMMENTS

Quitchumpah Allotment

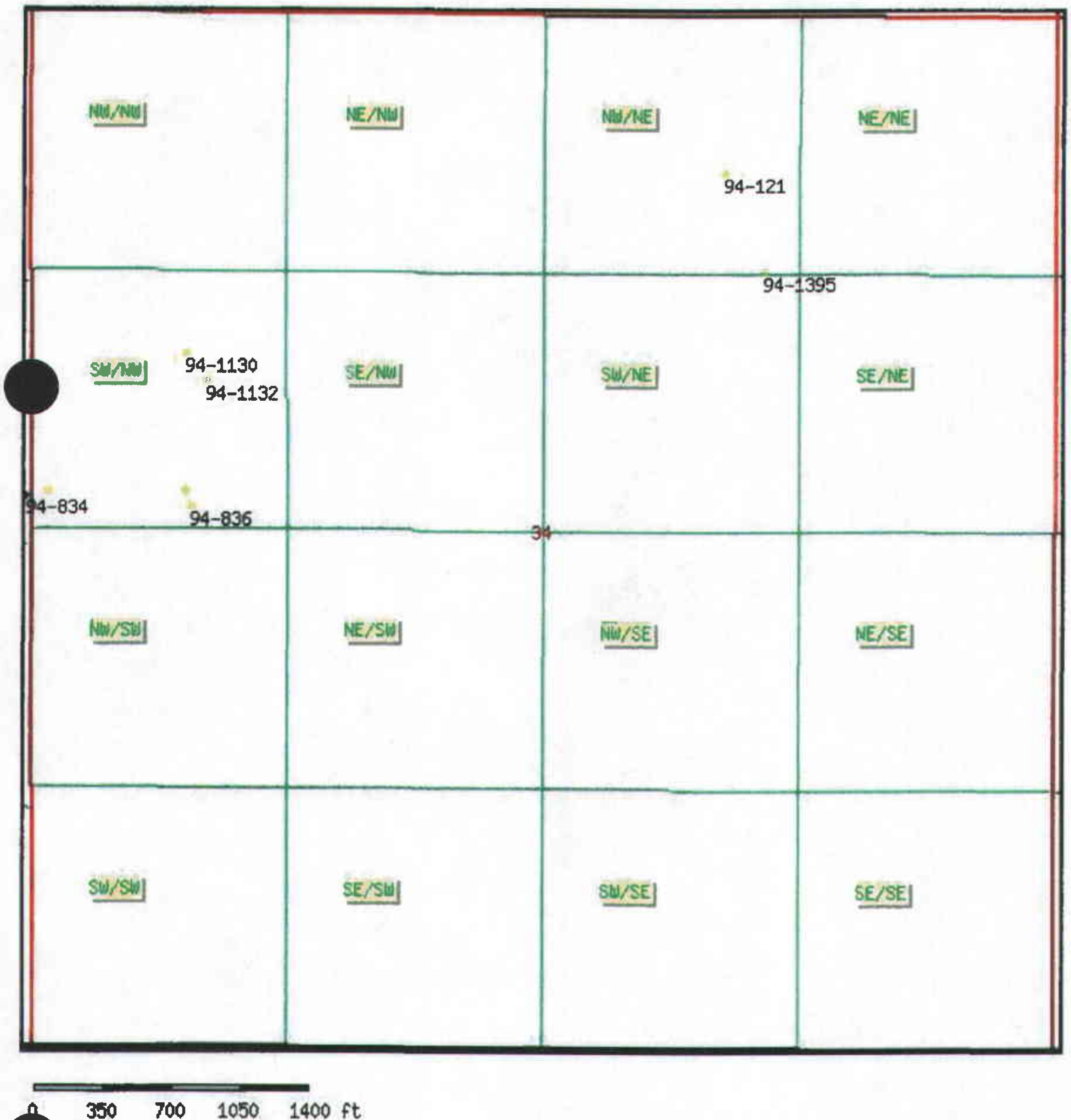
END OF DATA

Utah Division of Water Rights

Output Listing

Version: 2009.05.06.00 **Rundate: 06/08/2010 08:28 AM**

Search of Section 34, Township 21S, Range 4E, SL b&m Criteria:wrtypes=W,C,E podtypes=S,U,D,Sp, P,R,T status=U,A,P usetypes=all



Water Rights

WR Number	Diversion Type/Location	Well Log	Status	Priority	Uses	CFS	ACFT	Owner Name
94-1131	Point to Point S2450 E100 NW 34 21S 4E SL		P	18790000	OS	0.000	0.000	USA FOREST SERVICE 324 - 25TH STREET
94-1133	Point to Point S2450 E800 NW 34 21S 4E SL		P	18790000	S	0.000	0.000	USA FOREST SERVICE 324 - 25TH STREET
94-25	Point to Point S2450 E800 NW 34 21S 4E SL		P	19410124	D	0.006	0.000	USA FOREST SERVICE 324 - 25TH STREET
94-1133	Point to Point S2450 E100 NW 34 21S 4E SL		P	18790000	S	0.000	0.000	USA FOREST SERVICE OGDEN UT 84401
94-1130	Spring S1750 E800 NW 34 21S 4E SL		P	18790000	OS	0.015	0.000	USA FOREST SERVICE 324 - 25TH STREET
94-1132	Spring S1900 E900 NW 34 21S 4E SL		P	18790000	OS	0.015	0.000	USA FOREST SERVICE 324 - 25TH STREET
94-121	Spring S800 W1700 NE 34 21S 4E SL		P	18790000	OS	0.015	0.000	USA FOREST SERVICE 324 - 25TH STREET
94-1395	Spring S1300 W1500 NE 34 21S 4E SL		P	18790000	OS	0.015	0.000	USA FOREST SERVICE 324 - 25TH STREET
94-836	Surface S2540 E820 NW 34 21S 4E SL		P	18790000	OS	0.015	0.000	USA FOREST SERVICE 324 - 25TH STREET

STATE OF UTAH – DIVISION OF WATER RIGHTS – DATA PRINT OUT for 94-25(A14364)

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 94-25 APPLICATION/CLAIM NO.: A14364 CERT. NO.: 3878

OWNERSHIP

NAME: USA Forest Service
ADDR: 324 - 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: |PRIORITY: 01/24/1941|PUB BEGAN: |PUB ENDED: |NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [Approved]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: |LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]

PD BOOK: [94-1]|MAP: [*]|PUB DATE:

Type of Right: Application to Appropriate Source of Info: Proposed Determination Status: Certificate

LOCATION OF WATER RIGHT

FLOW: 0.0056 cfs SOURCE: Lizonbee Spring

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF DIVERSION:
(1)Domestic directly on spring located at S 2450 ft. E 800 ft. from NW corner, Sec 34, T21S, R4E, SLBM.

USES OF WATER RIGHT ELU -- Equivalent Livestock Unit (cow, horse, etc.) EDU -- Equivalent Domestic Unit or 1 Family

SUPPLEMENTAL GROUP NO. 618189.

DOMESTIC: 3.0000 EDUs Div Limit: PERIOD OF USE: 05/15 TO 10/31

###PLACE OF USE:	NORTH WEST QUARTER				NORTH EAST QUARTER				SOUTH WEST QUARTER				SOUTH EAST QUARTER				Section
	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE	Totals
Sec 34 T 21S R 4E SLBM			X														0.0000
																GROUP ACREAGE TOTAL:	0.0000

END OF DATA

STATE OF UTAH – DIVISION OF WATER RIGHTS – DATA PRINT OUT for 94-121

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 94-121 APPLICATION/CLAIM NO.: CERT. NO.:

CHANGES: a35187 Approved

OWNERSHIP

NAME: USA Forest Service
ADDR: 324 - 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1879|PUB BEGAN: |PUB ENDED: |NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: |LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]

PD BOOK: [94-1]|MAP: [*]|PUB DATE:

Type of Right: Diligence Claim Source of Info: Proposed Determination Status:

LOCATION OF WATER RIGHT

FLOW: 0.015 cfs SOURCE: Upper Mud Springs (001-015)

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF SPRING:
(1) S 800 ft W 1700 ft from NE cor, Sec 34, T 21S, R 4E, SLBM
Diverting Works: Source:

USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family

SUPPLEMENTAL GROUP NO. 425880. Water Rights Appurtenant to the following use(s):
63-2685(DIL),2710(DIL),2711(DIL),2725(DIL),2726(DIL),2742(DIL),2743(DIL),2772(DIL),2773(DIL),3361(DIL),3362(DIL),3363(DIL)
3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL),3373(DIL),3374(DIL),3375(DIL),3376(DIL)
3377(DIL),3378(DIL),3379(DIL),3380(DIL),3381(DIL),3382(DIL),3383(DIL),3384(DIL),3385(DIL),3386(DIL),3387(DIL),3388(DIL),3389(DIL)
3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL),3399(DIL),3400(DIL),3401(DIL),3402(DIL)
3403(DIL),3404(DIL),3405(DIL),3406(DIL),3407(DIL),3408(DIL),3409(DIL),3410(DIL),3494(DIL),3495(DIL),3496(DIL),3497(DIL),3498(DIL)
3499(DIL),3500(DIL),3501(DIL),3502(DIL),3503(DIL),3504(DIL),3505(DIL),3506(DIL),3507(DIL),3508(DIL),3509(DIL),3510(DIL),3511(DIL)
3512(DIL),3513(DIL),3514(DIL),3515(DIL),3516(DIL),3517(DIL),3518(DIL),3519(DIL),3520(DIL),3521(DIL),3522(DIL),3523(DIL),3524(DIL)
3525(DIL),3526(DIL),3527(DIL),3528(DIL),3529(DIL),3530(DIL),3531(DIL),3532(DIL),3533(DIL),3534(DIL),3535(DIL),3536(DIL),3537(DIL)
3538(DIL),3539(DIL),3540(DIL),94-110(DIL),111(DIL),112(DIL),113(DIL),114(DIL),115(DIL),116(DIL),117(DIL),118(DIL),119(DIL)
120(DIL),121(DIL),122(DIL),123(DIL),124(DIL),125(DIL),126(DIL),127(DIL),128(DIL),129(DIL),130(DIL),131(DIL),132(DIL),133(DIL)
134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC),1387(WUC),1388(WUC),1389(WUC)
1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC),1400(WUC),1401(WUC),1402(WUC)
1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC),1413(WUC),1414(WUC),1415(WUC)
1593(WUC),1594(WUC)

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 819.0000 Div Limit: PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

WILDLIFE: 1270 deer & 115 elk PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated
Quitchumpah Allotment

SUPPLEMENTAL GROUP NO. 617789. Water Rights Appurtenant to the following use(s):
63-3361(DIL),3362(DIL),3363(DIL),3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL)
3373(DIL),3374(DIL),3375(DIL),3376(DIL),3377(DIL),3378(DIL),3379(DIL),3380(DIL),3381(DIL),3382(DIL),3383(DIL),3384(DIL),3385(DIL)
3386(DIL),3387(DIL),3388(DIL),3389(DIL),3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL)
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130(DIL),131(DIL),132(DIL),133(DIL),134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC)
1387(WUC),1388(WUC),1389(WUC),1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC)
1400(WUC),1401(WUC),1402(WUC),1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC)
1413(WUC),1414(WUC),1415(WUC),1593(WUC),1594(WUC)

STOCKWATER: Sole Supply: 14.0000 ELUs of the Group Total of 81.0000 Div Limit: 12.70356 acft. PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

PLACE OF USE for STOCKWATERING

	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 34 T 21S R 4E SLBM	* : : : *	* X: : : *	* : : : *	* : : : *

OTHER COMMENTS

Map: Acord Lakes

E N D O F D A T A

STATE OF UTAH -- DIVISION OF WATER RIGHTS -- DATA PRINT OUT for 94-836

WATER RIGHT: 94-836 APPLICATION/CLAIM NO.: CERT. NO.:

CHANGES: a35187 Approved

==

OWNERSHIP***

==

NAME: USA Forest Service
ADDR: 324 - 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

==

DATES, ETC.***

==

LAND OWNED BY APPLICANT? COUNTY TAX ID#:

FILED:	PRIORITY: 00/00/1879	PUB BEGAN:	PUB ENDED:	NEWSPAPER:	
ProtestEnd:	PROTESTED: [No]	HEARNG HLD:	SE ACTION: [ ]	ActionDate:	PROOF DUE:
EXTENSION:	ELEC/PROOF: [ ]	ELEC/PROOF:	CERT/WUC:	LAP, ETC:	LAPS LETTER:
RUSH LETTR:	RENOVATE:	RECON REQ:	TYPE: [ ]		

PD BOOK: [94-1] | MAP: [*] | PUB DATE:

Type of Right: Diligence Claim Source of Info: Proposed Determination Status: Water User's Claim

==

LOCATION OF WATER RIGHT***

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FLOW: 0.015 cfs SOURCE: Lizonbee Spring #2

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) S 2540 ft E 820 ft from NW cor, Sec 34, T 21S, R 4E, SLBM
Diverting Works: Source:

Stream Alt Required?: No

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USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family

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SUPPLEMENTAL GROUP NO. 425880. Water Rights Appurtenant to the following use(s):
63-2685(DIL),2710(DIL),2711(DIL),2725(DIL),2726(DIL),2742(DIL),2743(DIL),2772(DIL),2773(DIL),3361(DIL),3362(DIL),3363(DIL)
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3403(DIL),3404(DIL),3405(DIL),3406(DIL),3407(DIL),3408(DIL),3409(DIL),3410(DIL),3494(DIL),3495(DIL),3496(DIL),3497(DIL),3498(DIL)
3499(DIL),3500(DIL),3501(DIL),3502(DIL),3503(DIL),3504(DIL),3505(DIL),3506(DIL),3507(DIL),3508(DIL),3509(DIL),3510(DIL),3511(DIL)
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1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC),1413(WUC),1414(WUC),1415(WUC)
1593(WUC),1594(WUC)

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STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 819.0000 Div Limit: PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

....

WILDLIFE: 1270 deer & 115 elk PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated
Quitchumpah Allotment

*==

SUPPLEMENTAL GROUP NO. 617789. Water Rights Appurtenant to the following use(s):
63-3361(DIL),3362(DIL),3363(DIL),3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL)
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1387(WUC),1388(WUC),1389(WUC),1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC)
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1413(WUC),1414(WUC),1415(WUC),1593(WUC),1594(WUC)

....

STOCKWATER: Sole Supply: 14.0000 ELUs of the Group Total of 81.0000 Div Limit: 12.70356 acft. PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

****
E N D O F D A T A
****

STATE OF UTAH – DIVISION OF WATER RIGHTS – DATA PRINT OUT for 94-1130

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 94-1130 APPLICATION/CLAIM NO.: CERT. NO.:

CHANGES: a35187 Approved

OWNERSHIP

NAME: USA Forest Service
ADDR: 324 - 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1879|PUB BEGAN: |PUB ENDED: |NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: |LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [[

PD BOOK: [94-1]|MAP: [*]|PUB DATE:

Type of Right: Diligence Claim Source of Info: Proposed Determination Status: Water User's Claim

LOCATION OF WATER RIGHT

FLOW: 0.015 cfs SOURCE: North Lizonbee Spring

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF SPRING:
(1) S 1750 ft E 800 ft from NW cor, Sec 34, T 21S, R 4E, SLBM
Diverting Works: Source:

USES OF WATER RIGHT ELU -- Equivalent Livestock Unit (cow, horse, etc.) EDU -- Equivalent Domestic Unit or 1 Family

SUPPLEMENTAL GROUP NO. 425880. Water Rights Appurtenant to the following use(s):
63-2685(DIL),2710(DIL),2711(DIL),2725(DIL),2726(DIL),2742(DIL),2743(DIL),2772(DIL),2773(DIL),3361(DIL),3362(DIL),3363(DIL)
3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL),3373(DIL),3374(DIL),3375(DIL),3376(DIL)
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3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL),3399(DIL),3400(DIL),3401(DIL),3402(DIL)
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1593(WUC),1594(WUC)

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 819.0000 Div Limit: PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

WILDLIFE: 1270 deer & 115 elk PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated
Quitchumpah Allotment

SUPPLEMENTAL GROUP NO. 617789. Water Rights Appurtenant to the following use(s):
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1387(WUC),1388(WUC),1389(WUC),1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC)
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1413(WUC),1414(WUC),1415(WUC),1593(WUC),1594(WUC)

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  STOCKWATER: Sole Supply: 14.0000 ELUs   of the Group Total of 81.0000     Div Limit: 12.70356 acft.  PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

=============================================================================================================================
PLACE OF USE for STOCKWATERING********************************************************************************************
=============================================================================================================================
                               NORTH-WEST¼      NORTH-EAST¼      SOUTH-WEST¼      SOUTH-EAST¼
                               NW NE SW SE      NW NE SW SE      NW NE SW SE      NW NE SW SE
Sec 34 T 21S R  4E SLBM        *  :  : X:  *    *  :  :  :  *    *  :  :  :  *    *  :  :  :  *
*****************************************************************************************************************************
*******************************************************E N D   O F   D A T A*************************************************
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STATE OF UTAH – DIVISION OF WATER RIGHTS – DATA PRINT OUT for 94-1131

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 94-1131 APPLICATION/CLAIM NO.: CERT. NO.:

CHANGES: a35187 Approved

==
OWNERSHIP**
==

NAME: USA Forest Service
ADDR: 324 - 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

==
DATES, ETC.**
==

LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1879|PUB BEGAN: |PUB ENDED: |NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: |LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]

PD BOOK: [94-1]|MAP: [*]|PUB DATE:

Type of Right: Diligence Claim Source of Info: Proposed Determination Status: Water User's Claim

==
LOCATION OF WATER RIGHT**
==

FLOW: SOURCE: Lizonbee Springs Creek

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:
(1)Stockwatering directly on stream from a point at S 2450 ft. E 100 ft. from NW corner, Sec 34, T21S, R4E, SLBM,
to a point at N 1 ft. W 510 ft. from SE corner, Sec 33, T21S, R4E, SLBM.
COMMENT: Administratively updated by State Engineer.

==
USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family
==
SUPPLEMENTAL GROUP NO. 425880. Water Rights Appurtenant to the following use(s):
63-2685(DIL),2710(DIL),2711(DIL),2725(DIL),2726(DIL),2742(DIL),2743(DIL),2772(DIL),2773(DIL),3361(DIL),3362(DIL),3363(DIL)
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134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC),1387(WUC),1388(WUC),1389(WUC)
1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC),1400(WUC),1401(WUC),1402(WUC)
1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC),1413(WUC),1414(WUC),1415(WUC)
1593(WUC),1594(WUC)
....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 819.0000 Div Limit: PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment
....
WILDLIFE: 1270 deer & 115 elk PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated
Quitchumpah Allotment
*===
SUPPLEMENTAL GROUP NO. 617789. Water Rights Appurtenant to the following use(s):
63-3361(DIL),3362(DIL),3363(DIL),3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL)
3373(DIL),3374(DIL),3375(DIL),3376(DIL),3377(DIL),3378(DIL),3379(DIL),3380(DIL),3381(DIL),3382(DIL),3383(DIL),3384(DIL),3385(DIL)
3386(DIL),3387(DIL),3388(DIL),3389(DIL),3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL)
3399(DIL),3400(DIL),3401(DIL),3402(DIL),3403(DIL),3404(DIL),3405(DIL),3406(DIL),3407(DIL),3408(DIL),3409(DIL),3410(DIL),3494(DIL)
3495(DIL),3496(DIL),3497(DIL),3498(DIL),3499(DIL),3500(DIL),3501(DIL),3502(DIL),3503(DIL),3504(DIL),3505(DIL),3506(DIL),3507(DIL)

3508(DIL),3509(DIL),3510(DIL),3511(DIL),3512(DIL),3513(DIL),3514(DIL),3515(DIL),3516(DIL),3517(DIL),3518(DIL),3519(DIL),3520(DIL)
3521(DIL),3522(DIL),3523(DIL),3524(DIL),3525(DIL),3526(DIL),3527(DIL),3528(DIL),3529(DIL),3530(DIL),3531(DIL),3532(DIL),3533(DIL)
3534(DIL),3535(DIL),3536(DIL),3537(DIL),3538(DIL),3539(DIL),3540(DIL),94-110(DIL),111(DIL),112(DIL),113(DIL),114(DIL),115(DIL)
116(DIL),117(DIL),118(DIL),119(DIL),120(DIL),121(DIL),122(DIL),123(DIL),124(DIL),125(DIL),126(DIL),127(DIL),128(DIL),129(DIL)
130(DIL),131(DIL),132(DIL),133(DIL),134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC)
1387(WUC),1388(WUC),1389(WUC),1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC)
1400(WUC),1401(WUC),1402(WUC),1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC)
1413(WUC),1414(WUC),1415(WUC),1593(WUC),1594(WUC)

STOCKWATER: Sole Supply: 14.0000 ELUs of the Group Total of 81.0000 Div Limit: 12.70356 acft. PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

PLACE OF USE for STOCKWATERING

	NORTH-WEST¼				NORTH-EAST¼				SOUTH-WEST¼				SOUTH-EAST¼			
	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE
Sec 33 T 21S R 4E SLBM																X
Sec 34 T 21S R 4E SLBM			X													

E N D O F D A T A

STATE OF UTAH – DIVISION OF WATER RIGHTS – DATA PRINT OUT for 94-1132

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 94-1132 APPLICATION/CLAIM NO.: CERT. NO.:

CHANGES: a35187 Approved

==
OWNERSHIP**
==

NAME: USA Forest Service
ADDR: 324 - 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

==
DATES, ETC.**
==

LAND OWNED BY APPLICANT? COUNTY TAX ID#:

FILED:	PRIORITY: 00/00/1879	PUB BEGAN:	PUB ENDED:	NEWSPAPER:	
ProtestEnd:	PROTESTED: [No]	HEARNG HLD:	SE ACTION: [ ]	ActionDate:	PROOF DUE:
EXTENSION:	ELEC/PROOF: [ ]	ELEC/PROOF:	CERT/WUC:	LAP, ETC:	LAPS LETTER:
RUSH LETTR:	RENOVATE:	RECON REQ:	TYPE: [ ]		

PD BOOK: [94-1] | MAP: [*] | PUB DATE:

Type of Right: Diligence Claim Source of Info: Proposed Determination Status: Water User's Claim

==
LOCATION OF WATER RIGHT**
==

FLOW: 0.015 cfs SOURCE: North Lizonbee Spring #2

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF SPRING:
(1) S 1900 ft E 900 ft from NW cor, Sec 34, T 21S, R 4E, SLBM
Diverting Works: Source:

==
USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family
==

SUPPLEMENTAL GROUP NO. 425880. Water Rights Appurtenant to the following use(s):
63-2685(DIL),2710(DIL),2711(DIL),2725(DIL),2726(DIL),2742(DIL),2743(DIL),2772(DIL),2773(DIL),3361(DIL),3362(DIL),3363(DIL)
3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL),3373(DIL),3374(DIL),3375(DIL),3376(DIL)
3377(DIL),3378(DIL),3379(DIL),3380(DIL),3381(DIL),3382(DIL),3383(DIL),3384(DIL),3385(DIL),3386(DIL),3387(DIL),3388(DIL),3389(DIL)
3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL),3399(DIL),3400(DIL),3401(DIL),3402(DIL)
3403(DIL),3404(DIL),3405(DIL),3406(DIL),3407(DIL),3408(DIL),3409(DIL),3410(DIL),3494(DIL),3495(DIL),3496(DIL),3497(DIL),3498(DIL)
3499(DIL),3500(DIL),3501(DIL),3502(DIL),3503(DIL),3504(DIL),3505(DIL),3506(DIL),3507(DIL),3508(DIL),3509(DIL),3510(DIL),3511(DIL)
3512(DIL),3513(DIL),3514(DIL),3515(DIL),3516(DIL),3517(DIL),3518(DIL),3519(DIL),3520(DIL),3521(DIL),3522(DIL),3523(DIL),3524(DIL)
3525(DIL),3526(DIL),3527(DIL),3528(DIL),3529(DIL),3530(DIL),3531(DIL),3532(DIL),3533(DIL),3534(DIL),3535(DIL),3536(DIL),3537(DIL)
3538(DIL),3539(DIL),3540(DIL),94-110(DIL),111(DIL),112(DIL),113(DIL),114(DIL),115(DIL),116(DIL),117(DIL),118(DIL),119(DIL)
120(DIL),121(DIL),122(DIL),123(DIL),124(DIL),125(DIL),126(DIL),127(DIL),128(DIL),129(DIL),130(DIL),131(DIL),132(DIL),133(DIL)
134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC),1387(WUC),1388(WUC),1389(WUC)
1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC),1400(WUC),1401(WUC),1402(WUC)
1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC),1413(WUC),1414(WUC),1415(WUC)
1593(WUC),1594(WUC)

....
STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 819.0000 Div Limit: PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

....
WILDLIFE: 1270 deer & 115 elk PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated
Quitchumpah Allotment

*===
SUPPLEMENTAL GROUP NO. 617789. Water Rights Appurtenant to the following use(s):
63-3361(DIL),3362(DIL),3363(DIL),3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL)
3373(DIL),3374(DIL),3375(DIL),3376(DIL),3377(DIL),3378(DIL),3379(DIL),3380(DIL),3381(DIL),3382(DIL),3383(DIL),3384(DIL),3385(DIL)
3386(DIL),3387(DIL),3388(DIL),3389(DIL),3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL)
3399(DIL),3400(DIL),3401(DIL),3402(DIL),3403(DIL),3404(DIL),3405(DIL),3406(DIL),3407(DIL),3408(DIL),3409(DIL),3410(DIL),3494(DIL)
3495(DIL),3496(DIL),3497(DIL),3498(DIL),3499(DIL),3500(DIL),3501(DIL),3502(DIL),3503(DIL),3504(DIL),3505(DIL),3506(DIL),3507(DIL)

3508(DIL),3509(DIL),3510(DIL),3511(DIL),3512(DIL),3513(DIL),3514(DIL),3515(DIL),3516(DIL),3517(DIL),3518(DIL),3519(DIL),3520(DIL)
3521(DIL),3522(DIL),3523(DIL),3524(DIL),3525(DIL),3526(DIL),3527(DIL),3528(DIL),3529(DIL),3530(DIL),3531(DIL),3532(DIL),3533(DIL)
3534(DIL),3535(DIL),3536(DIL),3537(DIL),3538(DIL),3539(DIL),3540(DIL),94-110(DIL),111(DIL),112(DIL),113(DIL),114(DIL),115(DIL)
116(DIL),117(DIL),118(DIL),119(DIL),120(DIL),121(DIL),122(DIL),123(DIL),124(DIL),125(DIL),126(DIL),127(DIL),128(DIL),129(DIL)
130(DIL),131(DIL),132(DIL),133(DIL),134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC)
1387(WUC),1388(WUC),1389(WUC),1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC)
1400(WUC),1401(WUC),1402(WUC),1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC)
1413(WUC),1414(WUC),1415(WUC),1593(WUC),1594(WUC)

STOCKWATER: Sole Supply: 14.0000 ELUs of the Group Total of 81.0000 Div Limit: 12.70356 acft. PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

PLACE OF USE for STOCKWATERING

	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 34 T 21S R 4E SLBM	* : : X: *	* : : : *	* : : : *	* : : : *

END OF DATA

STATE OF UTAH – DIVISION OF WATER RIGHTS – DATA PRINT OUT for 94-1133

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 94-1133 APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP

NAME: USA Forest Service
ADDR: 324 - 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? COUNTY TAX ID#:
FILED: |PRIORITY: 00/00/1879|PUB BEGAN: |PUB ENDED: |NEWSPAPER:
ProtestEnd: |PROTESTED: [No]|HEARNG HLD: |SE ACTION: [ ]|ActionDate: |PROOF DUE:
EXTENSION: |ELEC/PROOF:[ ]|ELEC/PROOF: |CERT/WUC: |LAP, ETC: |LAPS LETTER:
RUSH LETTR: |RENOVATE: |RECON REQ: |TYPE: [ ]

PD BOOK: [94-1]|MAP: [*]|PUB DATE:

Type of Right: Diligence Claim Source of Info: Proposed Determination Status: Water User's Claim

LOCATION OF WATER RIGHT

FLOW: SOURCE: Lizonbee Springs Creek

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF DIVERSION -- POINT TO POINT:
(1)Stockwatering directly on stream from a point at S 2450 ft. E 800 ft. from NW corner, Sec 34, T21S, R4E, SLBM,
to a point at S 2450 ft. E 100 ft. from NW corner, Sec 34, T21S, R4E, SLBM.

USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family

SUPPLEMENTAL GROUP NO. 617799.

STOCKWATER: 8.0000 Stock Units Div Limit: PERIOD OF USE: 05/01 TO 10/31

PLACE OF USE for STOCKWATERING

	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 34 T 21S R 4E SLBM	* : : X: *	* : : : *	* : : : *	* : : : *

E N D O F D A T A

STATE OF UTAH -- DIVISION OF WATER RIGHTS -- DATA PRINT OUT for 94-1395

(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 06/08/2010 Page 1

WATER RIGHT: 94-1395 APPLICATION/CLAIM NO.: CERT. NO.:

CHANGES: a35187 Approved

OWNERSHIP

NAME: USA Forest Service
ADDR: 324 - 25th Street
Ogden UT 84401
INTEREST: 100% REMARKS:

DATES, ETC.

LAND OWNED BY APPLICANT? COUNTY TAX ID#:

FILED:	PRIORITY: 00/00/1879	PUB BEGAN:	PUB ENDED:	NEWSPAPER:	
ProtestEnd:	PROTESTED: [No]	HEARNG HLD:	SE ACTION: [ ]	ActionDate:	PROOF DUE:
EXTENSION:	ELEC/PROOF:[ ]	ELEC/PROOF:	CERT/WUC:	LAP, ETC:	LAPS LETTER:
RUSH LETTR:	RENOVATE:	RECON REQ:	TYPE: [ ]		

PD BOOK: [94-1] |MAP: [*] |PUB DATE:

Type of Right: Diligence Claim Source of Info: Proposed Determination Status: Water User's Claim

LOCATION OF WATER RIGHT

FLOW: 0.015 cfs SOURCE: Upper Mud Springs

COUNTY: Sevier COMMON DESCRIPTION:

POINT OF SPRING:
(1) S 1300 ft W 1500 ft from NE cor, Sec 34, T 21S, R 4E, SLBM
Diverting Works: Source:

USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family

SUPPLEMENTAL GROUP NO. 425880. Water Rights Appurtenant to the following use(s):
63-2685(DIL),2710(DIL),2711(DIL),2725(DIL),2726(DIL),2742(DIL),2743(DIL),2772(DIL),2773(DIL),3361(DIL),3362(DIL),3363(DIL)
3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL),3373(DIL),3374(DIL),3375(DIL),3376(DIL)
3377(DIL),3378(DIL),3379(DIL),3380(DIL),3381(DIL),3382(DIL),3383(DIL),3384(DIL),3385(DIL),3386(DIL),3387(DIL),3388(DIL),3389(DIL)
3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL),3399(DIL),3400(DIL),3401(DIL),3402(DIL)
3403(DIL),3404(DIL),3405(DIL),3406(DIL),3407(DIL),3408(DIL),3409(DIL),3410(DIL),3494(DIL),3495(DIL),3496(DIL),3497(DIL),3498(DIL)
3499(DIL),3500(DIL),3501(DIL),3502(DIL),3503(DIL),3504(DIL),3505(DIL),3506(DIL),3507(DIL),3508(DIL),3509(DIL),3510(DIL),3511(DIL)
3512(DIL),3513(DIL),3514(DIL),3515(DIL),3516(DIL),3517(DIL),3518(DIL),3519(DIL),3520(DIL),3521(DIL),3522(DIL),3523(DIL),3524(DIL)
3525(DIL),3526(DIL),3527(DIL),3528(DIL),3529(DIL),3530(DIL),3531(DIL),3532(DIL),3533(DIL),3534(DIL),3535(DIL),3536(DIL),3537(DIL)
3538(DIL),3539(DIL),3540(DIL),94-110(DIL),111(DIL),112(DIL),113(DIL),114(DIL),115(DIL),116(DIL),117(DIL),118(DIL),119(DIL)
120(DIL),121(DIL),122(DIL),123(DIL),124(DIL),125(DIL),126(DIL),127(DIL),128(DIL),129(DIL),130(DIL),131(DIL),132(DIL),133(DIL)
134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC),1387(WUC),1388(WUC),1389(WUC)
1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC),1400(WUC),1401(WUC),1402(WUC)
1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC),1413(WUC),1414(WUC),1415(WUC)
1593(WUC),1594(WUC)

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 819.0000 Div Limit: PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

WILDLIFE: 1270 deer & 115 elk PERIOD OF USE: 01/01 TO 12/31
Acre Feet Contributed by this Right for this Use: Unevaluated
Quitchumpah Allotment

SUPPLEMENTAL GROUP NO. 617789. Water Rights Appurtenant to the following use(s):
63-3361(DIL),3362(DIL),3363(DIL),3364(DIL),3365(DIL),3366(DIL),3367(DIL),3368(DIL),3369(DIL),3370(DIL),3371(DIL),3372(DIL)
3373(DIL),3374(DIL),3375(DIL),3376(DIL),3377(DIL),3378(DIL),3379(DIL),3380(DIL),3381(DIL),3382(DIL),3383(DIL),3384(DIL),3385(DIL)
3386(DIL),3387(DIL),3388(DIL),3389(DIL),3390(DIL),3391(DIL),3392(DIL),3393(DIL),3394(DIL),3395(DIL),3396(DIL),3397(DIL),3398(DIL)
3399(DIL),3400(DIL),3401(DIL),3402(DIL),3403(DIL),3404(DIL),3405(DIL),3406(DIL),3407(DIL),3408(DIL),3409(DIL),3410(DIL),3494(DIL)
3495(DIL),3496(DIL),3497(DIL),3498(DIL),3499(DIL),3500(DIL),3501(DIL),3502(DIL),3503(DIL),3504(DIL),3505(DIL),3506(DIL),3507(DIL)

3508(DIL),3509(DIL),3510(DIL),3511(DIL),3512(DIL),3513(DIL),3514(DIL),3515(DIL),3516(DIL),3517(DIL),3518(DIL),3519(DIL),3520(DIL)
3521(DIL),3522(DIL),3523(DIL),3524(DIL),3525(DIL),3526(DIL),3527(DIL),3528(DIL),3529(DIL),3530(DIL),3531(DIL),3532(DIL),3533(DIL)
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116(DIL),117(DIL),118(DIL),119(DIL),120(DIL),121(DIL),122(DIL),123(DIL),124(DIL),125(DIL),126(DIL),127(DIL),128(DIL),129(DIL)
130(DIL),131(DIL),132(DIL),133(DIL),134(DIL),135(DIL),218(DIL),834(WUC),835(WUC),836(WUC),1130(WUC),1131(WUC),1132(WUC),1386(WUC)
1387(WUC),1388(WUC),1389(WUC),1390(WUC),1391(WUC),1392(WUC),1393(WUC),1394(WUC),1395(WUC),1396(WUC),1397(WUC),1398(WUC),1399(WUC)
1400(WUC),1401(WUC),1402(WUC),1403(WUC),1404(WUC),1405(WUC),1406(WUC),1407(WUC),1408(WUC),1409(WUC),1410(WUC),1411(WUC),1412(WUC)
1413(WUC),1414(WUC),1415(WUC),1593(WUC),1594(WUC)

STOCKWATER: Sole Supply: 14.0000 ELUs of the Group Total of 81.0000 Div Limit: 12.70356 acft. PERIOD OF USE: 05/01 TO 10/31
Quitchumpah Allotment

PLACE OF USE for STOCKWATERING

	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 34 T 21S R 4E SLBM	* : : : *	* X: : : *	* : : : *	* : : : *

Storage from 01/01 to 12/31, inclusive, in Upper Mud Springs Reservoir with a maximum capacity of 0.200 acre-feet, located in:

	NORTH-WEST¼	NORTH-EAST¼	SOUTH-WEST¼	SOUTH-EAST¼
Height of Dam:				
Area Inundated:	NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 34 T 21S R 4E SLBM	* : : : *	* X: : : *	* : : : *	* : : : *

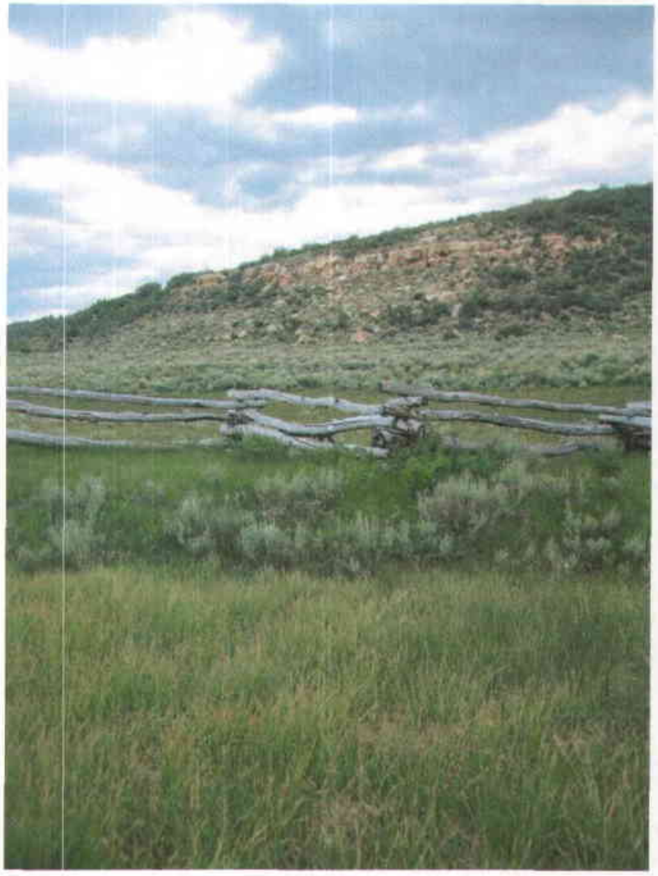
Small Dam Required?: No

E N D O F D A T A

APPENDIX 7-24

Investigation of Surface and Groundwater Systems in the West Lease Modifications Area, Sevier County, Utah: Probable Hydrologic Consequences of Coal Mining in the West Lease Modifications and Recommendations for Surface and Groundwater Monitoring

Investigation of Groundwater And Surface-Water Systems In the West Lease Modification Area; Probable Hydrologic Consequences of Coal Mining And Recommendations for Groundwater and Surface-Water Monitoring



16 August 2010

Canyon Fuel Company, LLC
Sufco Mine
Salina, Utah

PETERSEN HYDROLOGIC, LLC
CONSULTANTS IN HYDROGEOLOGY

Investigation of Groundwater And Surface-Water Systems In the West Lease Modification Area; Probable Hydrologic Consequences of Coal Mining And Recommendations for Groundwater and Surface-Water Monitoring

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Canyon Fuel Company, LLC
Sufco Mine
Salina, Utah

Prepared by:

LICENSED PROFESSIONAL GEOLOGIST
ERIK CARL PETERSEN
No. 5373615-2250
STATE OF UTAH

Erik C. Petersen, P.G.
Senior Hydrogeologist
Utah P.G. No. 5373615-2250

PETERSEN HYDROLOGIC
CONSULTANTS IN HYDROGEOLOGY

2695 N. 600 E.
LEHI, UTAH 84043
(801) 766-4006
PETERSEN@RELIA.NET

Table of Contents

List of Figures

List of Tables

List of Appendices

1.0 Introduction

The Canyon Fuel Company, LLC (CFC) Sufco Mine is located approximately 30 miles east of Salina, Utah in the Wasatch Plateau coal mining district (Figure 1). The mine has been in operation since 1941. It is proposed that the existing underground Sufco Mine workings be extended into coal reserves located immediately west of and contiguous with the current Sufco Mine permit area (Figure 2). The new proposed mining area is referred to herein as the West Lease Modification Area (West Lease). No surface disturbances are currently proposed within the West Lease area. Current plans call for the West Lease coal reserves to be accessed through new mine portals that are currently being constructed near or within the existing Sufco Mine surface facilities. The mine portals are located within the existing permitted area.

Including this introduction, this report contains the following sections:

1. Introduction
2. Methods of Investigation
3. Physiographic Setting
4. Climate
5. Geology
6. Presentation of Data
7. Groundwater and Surface-Water Solute Compositions
8. Groundwater Isotopic Compositions
9. Description of Groundwater Systems
10. Description of Surface-water Systems
11. Determination of Probable Hydrologic Consequences of Coal Mining
12. Recommended Monitoring Plan
13. References Cited

2.0 Methods of Investigation

The hydrology and hydrogeology of the West Lease and surrounding areas have been evaluated based on an analysis of: 1) solute and isotopic compositions of groundwaters, 2) surface-water and groundwater discharge data, 3) potentiometric data, and 4) geologic information. Specific methods of investigation are described below.

Maps and reports

Existing published and unpublished hydrologic, hydrogeologic, and geologic maps were obtained and reviewed. Several investigations of the hydrogeology and hydrology of the Sufco Mine permit and adjacent areas have been completed prior to this investigation. The USGS, in cooperation with the BLM (Thiros and Cordy, 1991), described the hydrology and potential effects of mining in the Quitchupah and Pines coal mining Tracts. Mayo and Associates (1997) described surface water and groundwater systems and mining-related hydrologic impacts in the adjacent existing SUFCO Mine permit area. Petersen Hydrologic (2009) characterized groundwater and surface-water systems and evaluated the effects of subsidence of Castlegate Sandstone springs and streams in the East Fork of Box Canyon Creek drainage.

Collection of water quality and flow data

An inventory of springs, seeps, and streams in the West Lease and surrounding area was performed as part of this investigation. Additionally, maps and reports from previous spring and seep surveys in the area were obtained and reviewed. As part of this investigation, baseline monitoring of selected springs, streams, and wells in the West Lease and surrounding area was performed. Some baseline monitoring sites used in developing this Probable Hydrologic Consequences report (PHC), including streams, springs, and monitoring wells have also been monitored previously as part of the Sufco Mine's ongoing water monitoring activities. Additional pertinent hydrologic data were compiled from USGS Water-Resources Investigations Report 90-4084 (Thiros and Cordy, 1991) and utilized in this investigation.

Collection and analysis of isotopic data

As part of this and previous investigations, samples for stable and unstable isotopic analysis have been collected and analyzed. Samples were collected from surface locations (springs and streams) and from underground in-mine locations within the Sufco Mine. Samples for radiocarbon (^{14}C) were analyzed using conventional or Accelerator Mass Spectrometry (AMS) analytical techniques by Geochron Laboratories of Cambridge, Massachusetts. Other radiocarbon determinations were performed by the Brigham Young University Laboratory of Isotope Geochemistry of Provo, Utah. Tritium analyses were performed by Geochron Laboratories, the University of Miami Tritium Laboratory of Miami, Florida, and by the Brigham Young University Laboratory of Isotope Geochemistry. Stable isotopic carbon-13, deuterium, and oxygen-18 analyses were performed by Geochron Laboratories, Mountain Mass Spectrometry of Evergreen, Colorado, and the BYU Laboratory of Isotope Geochemistry.

Groundwater mean residence times were determined using methods described by Pearson and Hanshaw (1970), Fontes (1980), and Mookes (1980).

Climate Data

Precipitation data was obtained from the Salina 24 E NOAA Weather Station, which is located at the Sufco Mine surface facilities location. Continuous precipitation data from this station are available from 1984 to the present. Palmer Hydrologic Drought Index (PHDI) data are compiled monthly by the National Climatic Data Center (NCDC) and are available on-line. These climatic data were obtained, compiled and analyzed graphically and statistically as part of this investigation.

Data compilation

The hydrologic data used in this study were obtained primarily from the Division of Oil, Gas and Mining's on-line coal water quality database located at http://ogm.utah.gov/coal/edi/wqdb.htm. Hydrologic data, including discharge, water level, and water quality data, are routinely submitted to the database by mining operators and are freely accessible on-line. Hydrologic data from the Division's database together with data from other sources was compiled into a coherent electronic database for analysis in this investigation.

Data analysis

Geochemical, isotopic, discharge rate, potentiometric, and other data were analyzed by graphical and statistical methods. Solute compositions were graphically analyzed using Stiff (1951) diagrams.

3.0 Physiographic Setting

The West Lease area is situated in the Wasatch Plateau physiographic province of central Utah. The West Lease area consists primarily of an upland plateau that is truncated on the south and southeast by the steep erosional escarpments of Convulsion and East Spring Canyons (Figure 2). To the west, the region is bounded by the Acord Lakes structural valley.

The land surface in the West Lease area slopes generally to the south and southeast from the higher elevation regions in the northern portion of the West Lease that includes Duncan Mountain. In the extreme northwest portion of the lease area, the land surface slopes toward the South Fork of Quitchupah Creek to the north. The upland plateau is dissected by a series of broad erosional valleys that include Duncan Draw, Mud Spring Hollow, and Broad Hollow/Pin Hollow. The upland plateau area rolls gently and is vegetated primarily with sagebrush, grasslands, and isolated stands of Ponderosa Pines and aspen. The mountainous regions are typically vegetated with aspen and conifer forests interspersed with bushes, sagebrush, and grasslands. Vegetation on the sheer rock cliff faces in the deep canyons is sparse.

Surface topographic relief in the area exceeds 1,800 feet, ranging from an elevation of 9,251 feet at the summit of Duncan Mountain in the northeast portion of the West Lease area to approximately 7,400 feet in Convulsion Canyon in the southeast corner of the lease area.

Coal was first mined at the Sufco Mine site during 1941 using traditional room and pillar mining techniques. Second mining (pillar extraction) techniques were first used in 1976. Longwall mining techniques were first used at the mine in October 1985.

4.0 Climate

Precipitation in the vicinity of the Sufco Mine area is dependent on elevation. Annual precipitation in the vicinity ranges from 12 inches in the lower elevations to more than 20 inches in the higher elevations. Localized thunderstorms occur from July through November and contribute about half of the total annual precipitation (Thiros and Cordy, 1991). Mean monthly temperatures measured at the Emery 15 SW weather station, located about seven miles southeast of the study area, are below freezing from November to March. Snow depths measured between 1945 and 1985 at the Blacks Forks snow course, located about six miles northwest of the study area at an elevation of 9,200 feet, averaged 44 inches, with a water content of 14.4 inches (Whaley and Lytton, 1979).

Annual precipitation data from the NOAA Salina 24E weather station, which is located at the Sufco Mine surface facilities location less than a mile from the West Lease area, are plotted in Figure 3. Continuous precipitation data from this station are available for the period from 1984 through June 2010. It is apparent that the region experienced above normal precipitation during the mid 1980s, followed by a period of near normal precipitation between 1989 and 1995, with some years above and some years below average. The period of 1996 to 1999 was characterized by three consecutive years of substantially greater than normal precipitation. Beginning in the 1999-2000 water year, the region transitioned to a period of prolonged lower than normal precipitation that has lasted until the present, with the exception of a single substantially wetter than normal year during 2004-2005. It is noteworthy that of the past 10 water years, 9 of the 10 have been drier than normal.

Climatic conditions in the south-central portion of Utah have varied substantially during the period of baseline monitoring in the West Lease area. This is illustrated in a plot of the Palmer Hydrologic Drought Index (PHDI) for Utah Region 4 (Figure 4). The PHDI is a monthly value generated by the National Climatic Data Center using a variety of hydrologic parameters that indicates the severity of wet and dry spells. The PHDI is calculated from several hydrologic parameters including precipitation, temperature, evapotranspiration, soil water recharge, soil water loss, and runoff. Consequently, it is a useful tool for evaluating the relationship between climate and groundwater and surface water discharge data. It is apparent in Figure 4 that beginning in the early 1980s the region began a transition from a period of drought to a period of extreme wetness that peaked during 1983 and 1984. Subsequent to this period of extreme wetness, the region began an essentially continuous period of drying, peaking with a period of extreme drought in 1990. This period of drought persisted though 1992, when the region transitioned to a period characterized by alternating wet and dry spells that persisted through the end of 1996. Beginning in early 1997, the region transitioned into a three-year period of moderate to extreme wetness. Beginning in 2000, the region transitioned into a period of dryness that persisted approximately 4 years, followed by a brief period of extreme wetness that peaked during the spring of 2005. During 2006 the region transitioned into a period characterized primarily by mild to moderate drought that persists to the current time.

5.0 Geology

Four Cretaceous- to Tertiary-age bedrock formations crop out in the West Lease area (Figure 5). These include, in descending order, the North Horn Formation, Price River Formation, Castlegate Sandstone, and the Blackhawk Formation. Lying beneath these formations in the West Lease area and cropping out in Convulsion Canyon immediately east of the southern portion of the area are the Star Point Sandstone, and the Masuk Member of the Mancos

Shale. These geologic formations are shown on a geologic map in Figure 5. Each of these formations, and their water bearing and transmitting potential, is described briefly below.

North Horn Formation

The North Horn Formation consists of variegated (mainly shades of red) shales with minor sandstone, conglomerate, and freshwater limestone (Doelling, 1972). It is estimated to be about 1,490 feet thick in the study area, although no drilling in the area has penetrated both the upper and lower contacts of the formation. The lower contact of the formation is transitional with the underlying Price River Formation. The formation is vulnerable to mass movement, slope failures, and landslides (USFS, 2005). The North Horn Formation is present at the surface on Duncan Mountain in the northern portion of the West Lease area (Figure 5).

Because of the pervasiveness of low-permeability shale horizons in the North Horn Formation, vertical migration of groundwater through the formation is limited. Consequently, groundwater flow in the North Horn Formation occurs primarily though fractured or shallow weathered zones, or locally through sandstone paleochannels. For these reasons, groundwater recharge through the North Horn Formation to the underlying Price River Formation is likely not appreciable.

Price River Formation

The Price River Formation forms low-lying hills on the plateau in the West Lease and surrounding areas (Figure 5). The formation is reported to be approximately 550 feet thick in the existing Sufco permit area. The Price River Formation consists of gray to white gritty sandstone interbedded with shale and conglomerate deposited in a fluvial environment. The Price River Formation typically forms ledges and slopes due to the interbedding of resistant sandstones with less resistant shales and claystones.

While individual fluvial sandstones in the Price River Formation are capable of transmitting water, water is typically not transmitted over great vertical or horizontal distances in the formation. This is because of the lenticular geometry of the sandstone units and the interbedded low-permeability shales and claystone layers present in the formation.

Mayo and Associates (1997) noted that boreholes penetrating the Price River Formation in the Sufco Mine lease area have not encountered water in this unit. Mayo and Associates attributed the general lack of groundwater recharge in the Price River Formation to the combined factors of low precipitation, evapotranspiration of soil-zone moisture, and the presence of near-surface clayey horizons. The presence of the Price River Formation at the land surface over much of the West Lease, which greatly limits the potential for groundwater recharge to underlying strata, is likely largely responsible for the lack of significant groundwater resources in the West Lease area.

Castlegate Sandstone

The Castlegate Sandstone is a cliff-forming unit that comprises the rim rocks of the deeply incised canyons in the study area. The sandstone is directly exposed or covered by only a thin soil veneer on the plateau along the rims of the canyons. The Castlegate Sandstone is disconformably overlain by the Price River Formation, which forms low lying hills overlying the Castlegate Sandstone in much of the study area. The Castlegate Sandstone, which is about 200 feet thick in the study and adjacent area, is predominately massively-bedded, coarse-grained sandstone with some interbeds of shale, siltstone, and conglomerate. Pervasive silica and carbonate cement makes the formation well indurated and brittle. The Castlegate Sandstone was formed in a braided fluvial depositional system.

Although some of the sandstone rocks in the Castlegate are sufficiently permeable to transmit appreciable groundwater, groundwater flow through the pore spaces in the formation is limited. This is due primarily to the presence of mudstone drapes and bounding layers that are interbedded with the sandstone units in the formation. Near cliff exposures and in stream bottoms, the Castlegate Sandstone becomes friable due to the dissolution of the carbonate cement and is more capable of supporting shallow, active groundwater systems. Accordingly, groundwater flow in the Castlegate Sandstone in the study area often occurs thorough fracture and joint systems. Near-vertical jointing in the Castlegate Sandstone is pervasive and readily observable where the formation is exposed at the surface. Groundwater flow also occurs locally along bedding plains where permeable strata are sometimes underlain by the thin clay or shale perching layers that exist locally in the formation. The direction of bedding plain groundwater flow in the area is controlled by the local dip of the stratigraphic bedding horizons (which is generally toward the north-northwest). Because of the discontinuous nature of the shale layers, and the fact that permeable sandstone strata are not continuous over significant distances, long, regional-type flow systems generally do not develop in the Castlegate Sandstone. Rather, Castlegate Sandstone groundwater systems, where they exist, are typically local in nature with small to moderate quantities of groundwater discharged.

Where the Price River Formation, which generally does not support vertical migration of fluids, is present above the Castlegate Sandstone, the potential for recharge to the Castlegate Sandstone is minimal. Consequently, recharge to the Castlegate Sandstone commonly occurs where the formation is directly exposed at the surface, of where it is covered only by a thin covering of sandy sediments. In the West Lease area, the Castlegate Sandstone is exposed along the rims of the deeply incised canyons (which include East Spring Hollow, Broad Hollow, and Convulsion Canyon). The Castlegate Sandstone is underlain by the Blackhawk Formation, which acts as a basal confining layer, preventing appreciable vertical migration of groundwater from the unit into deeper strata. Consequently, it is common regionally for springs to originate near the base of the Castlegate Sandstone (Thiros and Cordy, 1991), or occasionally where thin shaley perching interbeds within the Castlegate Sandstone intersect the land surface.

Blackhawk Formation

The Blackhawk Formation in the study area consists of lenticular, discontinuous beds of sandstone, siltstone, mudstone, shale, and coal. The coal to be mined in the West Lease area is present in the Upper Hiawatha Coal seam in the lower portion of the Blackhawk Formation. The Upper Hiawatha Coal seam is underlain in the region by a sequence of shaley lagoonal deposits, ranging in thickness from 2 to 29 feet, which include the Lower Hiawatha Coal Seam (Mayo and Associates, 1997). In the study area, the upper 500 feet of the formation generally has massive, fine- to medium-grained, cliff-forming sandstone units (Thiros and Cordy, 1991). The number and thicknesses of sandstone units decreases toward the base of the unit. The lower 300 feet of the formation contains thinly-bedded sandstone and shale. The thickness of the Blackhawk Formation in the study and adjacent area is about 800 feet.

Because of the presence of interbedded low-permeability units in the Blackhawk Formation and the vertical and lateral discontinuity of sandstone horizons, the potential for vertical and horizontal movement of groundwater is limited. For this reason, groundwater flow in the formation occurs primarily through sandstone paleochannels, or occasionally through faults and fractures, while migration of groundwater across lithologies (either vertically or horizontally) is minimal. The direction of groundwater flow within permeable sandstone channels is largely constrained by the geometry of the sinuous channel structures and also by the structural dip of the strata. Because of the lenticular nature of the permeable strata in the Blackhawk Formation (both at a micro and macro scale), and the fact that individual sandstone channels often interpenetrate and are truncated, regional type groundwater flow regimes typically do not form.

The Blackhawk Formation is known to contain swelling clays that tend to naturally heal mining-induced fractures in the formation. Well drilling reports and laboratory analysis of samples indicate that the claystone layers in the Blackhawk Formation contain swelling clays which plastically deform when fractured (Mayo and Associates, 1997). Chempet Research

Corporation (1989) found that Blackhawk Formation claystone layers contain up to 58% montmorillonite.

Star Point Sandstone

The upper Star Point Sandstone consists of three massive sandstone layers, the uppermost of which intertongues with the Blackhawk Formation (Thiros and Cordy, 1991). The Star Point Sandstone is a tan to gray, fine- to medium- grained, friable, usually well-sorted sandstone containing minor thin interbeds of siltstone or claystone. The lower Star Point Sandstone is an upward prograding sequence that intertongues with the underlying Masuk Member of the Mancos Shale. The thickness of the Star Point Sandstone is about 200 feet in the study and surrounding area.

Groundwater flow in the Star Point Sandstone in the study area and regionally occurs primarily through joints, fractures, and faults. Appreciable groundwater flow through unfractured Star Point Sandstone bedrock is generally not observed (Bills, 2000).

Mancos Shale, Masuk Member

The Masuk Member of the Mancos Shale is 500 to 600 feet thick in the Muddy Creek Canyon area. The Masuk Member is exposed beneath the Star Point Sandstone cliffs in Convulsion Canyon west of the West Lease area (Figure 5). The Masuk Member consists of blue-gray fissile claystone or silty claystone which weathers light blue-gray to light tan. The unit contains thin calcareous sandy or silty interbeds that increase in frequency toward the top of the unit. It forms steep, barren, easily eroded slopes with occasional ledges of more resistant fine-grained sandstone, siltstone, or sandy claystone.

Because the unit is composed primarily of fine-grained marine sedimentary deposits (claystones and shales), the Mancos Shale has poor water-transmitting properties.

Structure

Major faulting has not been identified in the West Lease area. However, small displacement faults (apparent vertical displacement of about three feet or less) and some of greater displacement have been encountered in the SUFCO mine. A fault with approximately 16 feet of vertical displacement was noted in the underground mine workings near Duncan Draw (Personal communication, Chris Kravits, in Thiros and Cordy, 1991). These faults most commonly strike approximately N10° to 15°W and are inclined nearly vertical. Joints are both parallel and normal to the fault trend. Both minor faults and joints likely exist in the West Lease area (Personal communication, Mark Bunnell, 2010). Joints in the Castlegate Sandstone are common. The surface traces of these joints are up to approximately 1,000 feet in length and are spaced about 16 to 33 feet apart. The primary fracture orientation in the Sufco Mine area is approximately N 26° W, with a secondary set of fractures oriented about N 65° E also being measured (Thiros and Cordy, 1991).

An interesting geomorphic feature has been observed in the Mud Spring Hollow area near the eastern boundary of the West Lease area (Figure 5). A conspicuous north-northwest trending linear depression is present along the trend of the Mud Springs Fault Graben (See photographs section). The land surface within the graben, which is bounded by faults on both sides of the structure, slopes toward its center. The structure is developed on Price River Formation sediments which are present at the surface. The Price River Formation in this location is shallowly underlain by the Castlegate Sandstone (Figure 5). The Mud Springs Fault Graben creates a series of small closed drainage features that are isolated within the larger surrounding surface-water drainage pattern. In some locations within the graben, it is apparent that precipitation and snowmelt waters have been intercepted and drained into the graben via open channel flow. It should be noted that based on the geologic, geomorphologic, and vegetative conditions observed at the graben site, it does not appear that the closed drainage features associated with the graben are of recent origin. The fact that the fault graben and associated closed drainage features in this area have not been undermined by the Sufco Mine workings clearly indicates that the graben feature is not associated with mining-related subsidence.

In the Acord Lakes area, approximately 1 mile west of the West Lease area, an approximately north-south trending normal fault has been mapped along the eastern edge of the valley that has created a closed basin with at least 200 feet of vertical offset (Thiros and Cordy, 1991). This structural feature is likely responsible for the impoundment of water that creates Acord Lakes.

Rock units in the study area strike roughly 40°E and dip 1 to 2° (about 250 feet per mile) to the northwest. Local dips of the coal seam may range up to 10 degrees in areas where underlying paleochannels caused significant differential compaction.

6.0 Presentation of Data

Baseline hydrologic monitoring location details are listed on Table 1. Monitoring locations are shown on Figure 2. Discharge and water-quality data for springs and streams in the study area are presented in Table 2. Potentiometric data for wells in and around the West Lease area are presented in Table 3. Precipitation data from the Sufco Weather Station (1984-2010) are tabulated in Table 4. Stable and unstable isotopic compositions of springs, streams, and in-mine locations are presented in Table 5. Stiff (1951) diagrams depicting the average solute compositions of streams and springs are presented in Figure 6. Discharge hydrographs for springs and steams in the study area are plotted in Figure 7. Water level hydrographs for wells in the study area are presented in Figure 8. A map showing the principle surface-water drainages in the West Lease area is included as Figure 9.

7.0 Groundwater and surface-water solute compositions

Stiff diagrams depicting the solute chemical composition of groundwaters and surface waters in the West Lease area are shown on Figure 6. Stiff diagrams are a useful analytical tool that allows the graphical representation of groundwater and surface-water solute compositions. The shape of the Stiff diagram is a reflection of the geochemical type of the water, while the size of the diagram is related to the total dissolved solids concentration of the water.

Groundwaters discharging from springs and flowing in streams adjacent to the West Lease in commonly acquire their solute compositions through a series of well-documented chemical reactions. These are briefly summarized below.

Carbon dioxide gas is produced naturally in the soil at concentrations greatly exceeding atmospheric concentrations by root-zone respiration and also by the decay of organic matter. Recharge water (rain and snow melt), upon entering the soil mantle, reacts with CO_2 to produce carbonic acid according to:

$$CO_2 + H_2O = H_2CO_{3\ (\text{carbonic acid})} \qquad \text{(Equation 1)}$$

The produced carbonic acid subsequently dissociates into hydrogen ions (acid) and bicarbonate according to:

$$H_2CO_3 = H^+ + HCO_3^- \qquad \text{(Equation 2)}$$

The H^+ produced from Equation 2 reacts with carbonate minerals pervasive in the rocks of the Wasatch Plateau coal field, yielding calcium and magnesium ions and additional bicarbonate ions to the water according to:

$$CaCO_{3\ (\text{calcite})} + H^+ = Ca^{2+} + HCO_3^- \qquad \text{(Equation 3)}$$

and

$$CaMg(CO_3)_{2\ (\text{dolomite})} + 2H^+ = Ca^{2+} + Mg^{2+} + 2\ HCO_3^- \qquad \text{(Equation 4)}$$

Because of the limited solubility of calcite and dolomite in the absence of an additional source of CO_2, waters acquiring their solute compositions through the geochemical evolutionary pathway described in Equations 1 through 4 typically have relatively low TDS concentrations.

Groundwaters from formations containing soluble evaporite minerals often acquire a different solute geochemical type, and dissolved solids concentrations appreciably greater than that typically resulting from geochemical evolutionary pathway as described by equations 1-4 above. Surface waters flowing over sediments containing soluble evaporite minerals may also acquire elevated TDS concentrations and changed solute geochemical type. The geochemical reactions often responsible for these changes in chemical composition include:

$$CaSO_4 \cdot 2H_2O_{\ (gypsum)} = Ca^{2+} + SO_4^{2-} + 2H_2O \qquad \text{(Equation 5)}$$

$$NaCl_{\ (halite)} = Na^+ + Cl^- \qquad \text{(Equation 6)}$$

Waters rich in Ca^{2+} resulting from the dissolution of gypsum (Equation 5) may undergo ion exchange on clay minerals resulting in an increase in Na^+ concentrations at the expense of exchanged Ca^{2+} ions according to:

$$Ca^{2+} + \text{Na-clay} = 2Na^+ + \text{Ca-Clay} \qquad \text{(Equation 7)}$$

Ion exchange may also occur on zeolite minerals such as the sodium zeolite analcime according to:

$$2NaAlSi_2O_6 \cdot H_2O + Ca^{2+} = Ca(AlSi_2O6)_2 \cdot H_2O + 2Na^+ \qquad \text{(Equation 8)}$$

The average TDS concentrations of groundwaters in the West Lease and surrounding area range from about 200 to 750 (Table 2). Solute compositions of springs in the study area vary considerably by geologic formation.

North Horn Formation groundwater monitored at spring Sufco 057A is of the calcium-bicarbonate chemical type with an average TDS concentration of 322 mg/L. The solute composition is consistent with the dissolution of carbonate minerals (calcite and dolomite) in the presence of CO_2 gas.

Regionally, Price River Formation groundwaters are often substantially elevated in TDS concentration relative to the overlying North Horn Formation and underlying Castlegate Sandstone groundwater systems. This condition is likely the result of interactions with soluble minerals that are locally present in the formation. Within the West Lease study area, solute data from three springs in the Price River Formation are available. The average TDS concentration of these springs is 749 mg/L. Mud Spring, located in Mud Spring Hollow, is of the calcium-sulfate-bicarbonate chemical type with a TDS concentration of 799 mg/L. Spring GW-8 (Lizonbee Springs) discharges from Price River Formation/Alluvium at Lizonbee Springs and is of the sodium-calcium-bicarbonate-sulfate chemical type with an average TDS of 758 mg/L. The elevated sodium concentrations in GW-8 groundwater relative to the chloride concentration (expressed in milliequivalents per liter) suggest that ion exchange has occurred. Spring GW-9, also located at Lizonbee Springs, is of similar chemical composition and TDS (689 mg/L) to GW-8, with lesser concentrations of sodium, suggesting that the water has not undergone ion exchange reactions to the extent to which GW-8 groundwater has experienced ion exchange.

Solute geochemical data for groundwaters in the Castlegate Sandstone in the West Lease area are available from two springs (Broad Hollow Spring and East Spring) and from well US-80-2 (Table 2). Broad Hollow Spring discharges from the Castlegate Sandstone near the basal contact with the underlying Blackhawk Formation. Groundwater from this spring is of the calcium-bicarbonate geochemical type with appreciable amounts of sodium and magnesium also being present. The TDS concentration of this water is low (195 mg/L), which is reflective of minimal contact with soluble minerals along the groundwater flow path in the Castlegate Sandstone. Mayo and Associates (1997) attributed the low TDS of Castlegate Sandstone groundwaters to recharge occurring where $CO_{2(g)}$ is not abundant and the general lack of halite and gypsum in the formation. Low soil-zone CO_2 conditions occur where the barren rock surfaces of the Castlegate Sandstone are exposed at the surface. It is noteworthy that considerable iron staining is commonly present in the spring discharge area. Groundwater sampled at Broad Hollow Spring on 10 May 2010 contained 9.01 mg/L of total iron and 1.63 mg/L of dissolved iron. Manganese was also elevated in the Broad Hollow Spring groundwater, with concentrations of 1.165 mg/L and 1.103 mg/L total and dissolved Manganese, respectively. The source of the iron and manganese in Broad Spring is not known with certainty. However, it is likely a result of interactions between the shallow Castlegate Sandstone groundwater and sulfide minerals present in the rock strata along the groundwater flow path (potentially near the basal contact with the Blackhawk Formation).

East Spring (Sufco 001) discharges near the base of the Castlegate Sandstone in East Spring Canyon, which is situated about three-fourths of a mile east of the West Lease area (Figure 2). Groundwaters discharging at East Spring are of the calcium-magnesium-bicarbonate geochemical type with moderate TDS concentrations, averaging 306 mg/L. This geochemical composition is consistent with the dissolution of carbonate minerals in the presence of soil-zone CO_2 gas. Thiros and Cordy (1991) note that Castlegate Sandstone springs discharging near the base of the Castlegate Sandstone unit often have higher TDS concentrations than shallowly circulating groundwaters that discharging from the upper portion of the unit, likely because of increased opportunity for interactions between groundwaters and soluble minerals. Similar observations have been made during monitoring of springs in the Sufco Pines Tract and surrounding areas (DOGM, 2010). Castlegate Sandstone groundwater sampled from well US-80-2 is of similar geochemical type as that at East Spring, with a TDS concentration of 290 mg/L.

Spring discharge from the Blackhawk Formation in the West Lease, which outcrops in the deeply incised canyons in the southern portion of the study area, was not observed. As discussed previously, significant groundwater discharge from unfractured Blackhawk Formation bedrock is not anticipated. However, Blackhawk Formation groundwater is encountered underground in the Sufco Mine workings. Where encountered in the mine roof, the groundwater in the Sufco Mine is typically of the calcium-magnesium-bicarbonate type, with TDS concentrations typically on the order of 300 to 400 mg/L (Mayo and Associates, 1997, 1998). Locally, underground roof-drip groundwaters have increased sulfate concentrations with moderately increased TDS concentrations.

Groundwater from the Star Point Sandstone is monitored at Sufco monitoring point 047. Sufco 047 discharges water from fractured Star Point Sandstone in the canyon south of the Sufco Mine surface facilities. Discharge from this spring is collected in a buried collection system and stored in a storage tank for use as the mine surface facilities water supply. Sufco 047 water is of the calcium-magnesium-bicarbonate geochemical type with an average TDS concentration of 479 mg/L. This geochemical composition is consistent with the dissolution of carbonate minerals in the presence of soil-zone CO_2. It is interesting to note that the average discharge temperature from 047 is 26.3° C, which is substantially elevated relative to the mean annual air temperature in the region. It is considered most likely that the elevated discharge temperature at this spring is a result of interactions with bedrock strata that have locally been heated as a result of coal burn near the outcrops.

Solute geochemical data are available for three surface-water monitoring stations located near the West Lease (Figure 2; Table 2). These include Sufco 006 (South Fork Quitchupah Creek), Sufco 046 (Convulsion Canyon above the mine facilities), and 047A (East Spring canyon below the mine surface facilities). Stiff diagrams for these three stream monitoring sites are shown on Figure 6. Sufco 006 is of the no-dominant-cation-bicarbonate geochemical type with appreciable sulfate content. The average TDS concentration at Sufco 006 is 435 mg/L. Surface waters monitored at Sufco 046 are of the calcium-magnesium-bicarbonate-sulfate chemical type, with TDS concentrations averaging 596 mg/L (Table 2). Discharge monitored at Sufco 047A is similar to that monitered at Sufco 047, with a TDS concentration averaging 773 mg/L.

8.0 Groundwater isotopic compositions

Carbon-14

Carbon-14 analyses have been performed on groundwater from three springs in the West Lease area (Table 5). Additionally, numerous carbon-14 analyses have been performed in underground locations in the Sufco Mine (Mayo and Associates, 1997, 1999; Petersen Hydrologic, 2005). The results of these analyses are presented in Table 5.

Based on the known half-life of radiocarbon (approximately 5,570 years), it is possible to calculate the time since a groundwater became isolated from soil-zone CO_2 gas and shallow recharge sources. However, estimating the radiocarbon age of groundwaters is not as straightforward as estimating the age of dead organic matter. This is because groundwater acquires carbon from numerous sources, each of which must be accounted for in calculating a groundwater age. These sources may include "live" carbon from biogenic production of CO_2 in the soil zone, "dead" carbon from the dissolution of carbonate minerals in the soil zone, and the addition of both "live" and "dead" carbon by other processes. In the Wasatch Plateau region, groundwater commonly acquires its carbon through the following series of chemical reactions.

The partial pressure of CO_2 in the soil zone, which is largely derived through root-zone respiration greatly exceeds that of the atmosphere. The CO_2 reacts with water to produce carbonic acid according to:

$$CO_2 + H_2O = H_2CO_3$$

Carbonic acid dissociates to produce acid (H^+) and bicarbonate according to:

$$H_2CO_3 = H^+ + HCO_3^-$$

In western coal mines, where carbonate rocks are pervasive, the acid produced from the above equation rapidly reacts with carbonate minerals, which releases additional bicarbonate and calcium and/or magnesium ions according to:

$$CaCO_{3\,(calcite)} + H^+ = Ca^{2+} + HCO_3^-$$

Or

$$CaMg(CO_3)_{2\,(dolomite)} + 2H^+ = Ca^{2+} + Mg^{2+} + 2HCO_3^-$$

Thus, groundwater that follows this evolutionary pathway will acquire 50% of its carbon from soil-zone CO_2 and 50% of its carbon from the dissolution of carbonate minerals near the recharge zone. Because soil-zone CO_2 typically has a $\delta^{13}C$ value between about –18 and –27 ‰, most groundwaters that follow this geochemical evolutionary pathway have a $\delta^{13}C$ value in the range of approximately –9 to –13 ‰ (Mayo and Associates, 1999). The fact that the $\delta^{13}C$ values for the radiocarbon samples analyzed in this investigation are in or near this range supports the conclusion that groundwaters in the study area likely follow this geochemical evolutionary pathway.

Like tritium, radiocarbon can also be used to determine whether groundwater has a component of recent anthropogenic (human induced) carbon. As a result of atmospheric thermonuclear weapons testing, atmospheric ^{14}C levels increased dramatically above background levels. ^{14}C levels reached a peak of approximately two times background levels (200 pmC) in 1963. Thus, groundwaters with ^{14}C contents significantly greater than about 50 percent modern carbon (pmC) have a component of carbon with an activity significantly greater than 100 pmC. Groundwater that acquires its carbon through the dissolution of carbonate minerals in the presence of soil-zone CO_2 should have an A_o near 50 pmC (50% "live" soil-zone carbon with $\approx$ 100 pmC, and 50% "dead" carbonate mineral carbon with $\approx$ 0 pmC). As a result of above-ground thermonuclear testing, the ^{14}C activity of the atmosphere increased significantly above 100 pmC (with the modern 100 pmC standard being based on the 1950 radiocarbon activity; Clark and Fritz, 1997). Thus, it possible for a groundwater that recharged after about 1950 to have a ^{14}C activity greater than 50 pmC. For this reason, groundwater age dating models that do not take this into account may not correctly determine the actual residence time of the groundwater, sometimes even calculating a recharge date in the future (Mayo and Associates, 1999).

As shown in Table 5, carbon-14 analysis was performed on groundwater from the North Horn Formation spring Sufco 057A in Duncan Draw during baseflow conditions. The carbon-14 content of this spring of 109.53 pmC indicates the presence of anthropogenic carbon and clearly identifies a modern groundwater age for this water. The Castlegate Sandstone East Spring (Sufco 001) was also sampled for carbon-14 during baseflow conditions. Similarly, the carbon-14 content of 97.70 pmC clearly indicates anthropogenic carbon and a modern origin.

Spring Sufco 047, which discharges from the Star Point Sandstone in Convulsion Canyon below the mine surface facilities, was also sampled for carbon-14 content. The measured carbon-14 content of this spring (25.27 pmC) indicates a mean groundwater residence time of approximately 7,300 years (Mayo and Associates, 1997).

Tritium (3H)

Tritium is a radioactive isotope of hydrogen that is commonly used in groundwater investigations to differentiate between groundwaters that recharged prior to or after the advent of atmospheric thermonuclear weapons testing. Tritium, whose half-life is 12.43 years, forms naturally in the upper stratosphere by the interaction of ^{14}N with cosmic ray neutrons. Tritium is rapidly incorporated into water molecules and is removed from the atmosphere by precipitation. As several decades have now past since the cessation of atmospheric thermonuclear weapons testing, the tritium concentrations in the atmosphere have now declined to near natural background levels. In continental regions, current tritium concentrations are on the order of 5 – 15 TU (Clark and Fritz, 1997). Similar concentrations have recently been measured in streams and lakes in the Wasatch Plateau coal district of central Utah.

Tritium has been widely utilized in the hydrogeologic community using both qualitative and quantitative dating approaches (Clark and Fritz, 1997). However, in this investigation, tritium has been used only as a qualitative tool to determine whether groundwater has a component that recharged after the onset of above-ground thermonuclear weapons nuclear testing. No attempt to calculate an absolute "age" of groundwater has been attempted using tritium content. This is primarily because of uncertainties determining the tritium input level of the recharge water source(s) and the potential for mixing of waters of different origins along groundwater flowpaths.

Tritium concentrations in the four spring samples analyzed for tritium content in the West Lease area range from essentially zero to 28.5 TU.

Groundwater samples from springs containing tritium at concentrations greater than about 0.5 TU indicate that the springs discharge from groundwater systems that have received a significant component of recharge within the past approximately 50 years. Tritium data from springs Sufco 001 and Sufco 057A, both with tritium concentrations greater than 10 TU, clearly indicate significant modern recharge components for these springs.

The tritium concentration at spring Sufco 047 (0.1 to 0.2 TU), which is near the lower laboratory detection limit, indicates that this spring does not have any appreciable modern recharge component (within the past approximately 50 years). This finding is consistent with the old radiocarbon mean residence time determined with the carbon-14 analysis. Similarly, tritium concentrations at stream monitoring site Sufco 047A are low (0.8 TU). It is noteworthy that during baseflow conditions, the discharge from 047A is primarily derived from a series of springs along the stream bank a short distance above the monitoring point. The low tritium composition observed in Sufco 047A groundwater likely reflects discharge of old groundwater from the springs, with minimal additional contributions from atmospheric contamination or inflow of near-surface tritium-rich shallow waters to the stream in the zone between the spring area and the designated monitoring site.

9.0 Description of Groundwater Systems

Groundwater in the West Lease and surrounding area naturally discharges as springs and seeps from the North Horn Formation, Price River Formation, Castlegate Sandstone, and the Star Point Sandstone. Discharge hydrographs for selected springs in the West Lease area are presented in Figure 7. Water level hydrographs for wells in the study area are presented in Figure 8. Groundwater has been encountered in the Sufco Mine in moderate quantities in sandstone channels in the mine roof. These groundwater inflows are commonly short-lived and do not exhibit seasonal or climatic variability in discharge rates (Personal communication, Mark Bunnell, 2010; Mayo and Associates, 1997, 1999). Groundwater inflows into the mine through the mine floor are not common.

Generally speaking, groundwater resources are not appreciable in the West Lease area. Three spring areas have been developed within the West Lease and nearby surrounding areas for stockwatering use. These springs include Sufco 057A in Duncan Draw, Mud Spring in Mud Spring Hollow, and Broad Hollow Spring located in the Pin Hollow/Broad Hollow area. Spring Sufco 057A discharges only rarely in response to wet climatic cycles. In the recent past, Mud Spring has rarely discharged water. There is usually groundwater discharge at Broad Hollow Spring, although the quantity of water available is minimal, typically being less than 0.25 gpm. While a few other locations have historically been developed for stockwatering use in the region surrounding the West Lease (Figure 2), water was not observed in any of these locations during baseline monitoring activities.

A groundwater-derived baseflow component to discharge in stream drainages has not been observed in the West Lease area. Rather, all of the stream drainages in the West Lease are ephemeral in nature. Discharge was not observed in any of these drainages during the period of baseline monitoring activities. However, Quitchupah Creek and its tributaries in adjacent areas are perennial in nature and are routinely monitored by Sufco Mine as part of the hydrologic monitoring plan.

Groundwater systems in the greater Sufco Mine area (in both surface and in-mine locations) are associated with one of two fundamental types of groundwater flow regime. These two regimes are described by a fairly simple conceptual model that includes "active" and "inactive" groundwater flow regimes (Mayo et. al., 2003). The operation of these two regimes is fundamentally a consequence of the vertical and horizontal heterogeneity and discontinuity of the rock strata in the region. A discussion of the active- and inactive-zone groundwater regimes in the West Lease area is presented below.

Active-Zone Groundwater Systems

Active zone groundwater systems are characterized as having good hydraulic communication with groundwater or surface-water recharge sources and having active groundwater flow from recharge to discharge areas. Thus, they are dependent on annual recharge events and are affected by short-term climatic variability (East Spring typically exhibits little seasonal variability but responds to long-term climate variability). The elevated tritium concentrations (which indicate groundwaters that are less than about 50 years old) and the modern radiocarbon ages of spring waters in the study area indicate these springs discharge from active-zone groundwater systems (Table 5).

Discharge hydrographs for springs in the study area are presented in Figure 7. It is apparent in Figure 7 and Table 2 that with the exception of spring Sufco 047 (discussed below) all springs in the West Lease exhibit seasonal variations in discharge rate and they also respond to climatic variability. This supports the conclusion that these springs discharge from active-zone groundwater systems, and are not related to the deep, inactive-zone groundwater systems that are encountered in the underground workings of the Sufco Mine (discussed below).

The flow records for spring Sufco 047 indicate that this spring discharges groundwater in a different manner than do other springs in the region. While minor fluctuations in discharge rate are apparent in the discharge hydrograph for 047 (Figure 7), it is apparent that seasonal variation is generally not observed and a relatively constant discharge of about 25-30 gpm occurs. The source of some of the observed fluctuation in the discharge rate at 047 is likely a result of the collection system at the spring and the intermittent use of the stored water. When the storage tank is not full, discharge from the spring monitoring point (tank overflow) ceases. Monitoring of the spring occurs when the tank is overflowing; however, any extractions from the tank at the time of sampling will influence the discharge measurement. The lack of seasonal variability in the discharge rate and the old radiocarbon mean residence time and the lack of tritium at 047 suggest that this spring discharges from a deep Star Point Sandstone groundwater system that is isolated from the shallow active-zone system the feeds other springs in the West Lease area.

Active-zone groundwater systems can exist in the study area primarily where 1) there is adequate precipitation to facilitate groundwater recharge, 2) there is sufficient storage capacity in the near surface soils, porous rock units, and/or shallow, fractured bedrock horizons to sustain groundwater discharge for significant periods, and 3) there is a competent, impermeable perching layer present in the subsurface that prohibits the downward migration of groundwater. Downward migration of active-zone groundwaters into deeper horizons is prevented by the presence of low permeability bedrock horizons that are widely present in the study area, commonly creating perched groundwater conditions. The perched, shallow groundwater systems, being constrained largely by surface topography, are usually of limited aerial extent.

Inactive-Zone Groundwater Systems

Inactive-zone groundwater systems are characterized by old groundwater (commonly from about 2,000 to 19,000 years in the Wasatch Plateau coal mining district) and a general lack of hydraulic communication with the ground surface or active recharge sources (Mayo et. al., 2003). This condition is the result of the lack of recharge potential to deeper groundwater systems, either vertically or horizontally, because of 1) the abundance of low-permeability rocks in the rock sequence, and 2) the lenticular, discontinuous nature of the interbedded more permeable horizons that limits the extent of potential groundwater movement. Inactive-zone groundwater systems are not influenced by either annual recharge events or by short-term climatic variability. This is evidenced by the lack of seasonal or climatic discharge responses of groundwater inflows into the Sufco Mine. Rather, groundwater inflows encountered in the Sufco Mine typically drain rapidly after first being encountered (Personal communication, Mark Bunnell, 2010). All groundwater inflows into the Sufco Mine have been from inactive-zone systems, as evidenced by the radiocarbon ages of the waters and the lack of tritium in in-mine groundwaters (Table 5), and the lack of seasonal or climatic response in discharge rates.

Inactive-zone groundwaters in the Blackhawk Formation in the study area are not part of a regionally continuous aquifer. Groundwater in the inactive zone occurs primarily in isolated partitions created by the discontinuous nature of bedrock hydrostratigraphic horizons. Because these partitions are isolated both vertically and horizontally by low-permeable strata, lateral migration of groundwater in the deep Blackhawk Formation is limited. Historically, mining operations in the Sufco Mine have encountered groundwater in some portions of the mine, while other nearby locations have been dry. This condition demonstrates the limited groundwater recharge potential and the limited potential for lateral groundwater migration in the lenticular rock bodies of the Blackhawk Formation.

In an attempt to substantiate the conclusion that subsidence related fracturing has not induced the downward movement of modern, overlying groundwaters into the Sufco Mine, an investigation was performed by Mayo and Associates (1997) during which a sample of groundwater which drains an old, sealed longwall gob area was collected and analyzed for ^{3}H and ^{14}C. As described by Mayo and Associates, the sample site (1L 8E seals) was specifically chosen because it underlies a region which is known to have undergone substantial ground subsidence, and the rocks at the surface contain abundant subsidence-related fractures. Mining ceased in this area in 1989, and the outflow from this area has steadily decreased since that time. If groundwaters from shallow, overlying systems (which contain abundant anthropogenic carbon and tritium) were being intercepted by subsidence fractures and flowing downward into the mine, we would expect to find some of the modern water in this sample. Mayo and Associates found that this was not the case. The groundwater had a mean ^{14}C age of 13,000 years, and contained no tritium (0.00 T.U.). The fact that the discharge from this and other abandoned longwall areas consistently decrease with time also suggests that there is not good hydraulic communication between groundwater systems immediately overlying the mine and shallow overlying groundwaters.

Water level hydrographs for the three monitoring wells located in the West Lease area are presented in Figure 8. Well US-80-2 is completed in the Castlegate Sandstone. Wells US-81-3 and US-81-4 are completed in the upper Hiawatha Coal seam of the Blackhawk Formation. It is readily apparent from these hydrographs that groundwater systems monitored in these wells do not respond to seasonal recharge or to climatic variability. These conditions suggest isolation from shallow, seasonal recharge sources.

In the general sense, groundwater flow in the Blackhawk Formation is in the down-dip direction, with local flow directions being largely constrained by the geometry of the sinusoidal sandstone paleochannels through which groundwater may flow. Consequently, because of the discontinuous, isolated nature of saturated strata in the mine, and the localized perched groundwater conditions, it is not possible to create a meaningful potentiometric surface map of the Blackhawk Formation in the vicinity of the Sufco Mine.

10.0 Description of Surface-Water Systems

Surface-water drainages in the West Lease and surrounding area are delineated on Figure 9. The principal surface-water drainages include the South Fork of Quitchupah Creek drainage, The Duncan Draw drainage, the Mud Spring Hollow drainge, and the Broad Hollow drainage. With the exception of the South Fork of Quitchupah Creek (which typically contains discharge year-round), all of the surface water drainages overlying the West Lease are ephemeral in nature. Discharge was not observed in any of these drainages during the most recent period of baseline monitoring (2007-2010). Discharge in these drainages occurs only in direct response to torrential precipitation events and copious active snowmelt events.

It should be noted that stockwatering ponds have been created in several of the principal surface water drainages (including Duncan Draw, Mud Spring Hollow, and Pin Hollow) for the purpose of impounding seasonal surface water runoff for stockwatering use later in the year.

Surface-water drainage in the extreme northeast corner of the West Lease is to the north into the South Fork of Quitchupah Creek drainage (Figure 9). The Quitchupah Creek stream channel is not present anywhere within the West Lease boundary. The South Fork of Quitchupah Creek near the West Lease is routinely monitored by the Sufco Mine at monitoring point Sufco 006, which is located about ½ mile north of the West Lease boundary. A discharge hydrograph for Sufco 006 is provided as Figure 7f. It is apparent that discharge in the South Fork responds rapidly to both seasonal and climatic variability. It should be noted that there is a surface-water diversion in the upper reaches of the South Fork of Quitchupah Creek, through which surface-waters are diverted in varying amounts to the Skumpah Creek drainage to the west.

As shown on Figure 9, over most of the West Lease, surface water drainage is toward the south and southeast to Quitchupah Creek in Convulsion Canyon. The Duncan Draw surface water drainage is an ephemeral drainage through which much of the northern portion of the West Lease is drained. Surface waters in Duncan Draw flow in a southeasterly direction into East Spring Canyon (which is also an ephemeral drainage), which flows into Quitchupah Creek in Convulsion Canyon about ½ mile south of the Sufco Mine surface facilities. Based on observations made during baseline monitoring activities, it is apparent that persistent surface water is first present in Quitchupah Creek a short distance above the confluence with East Spring Canyon.

Surface waters in the central portion of the West Lease drain to the southeast through Mud Spring Hollow. Mud Spring Hollow is an ephemeral drainage that flows into the East Spring Canyon drainage at the Sufco Mine surface facilities location (Figure 9).

Surface waters in the southern portion of the West Lease drain toward the southeast through Broad Hollow, an ephemeral drainage. The Broad Hollow drainage flows into the Quitchupah Creek drainage in Convulsion Canyon approximately 1 mile west of the confluence of East Spring Canyon and Quitchupah Creek (Figure 9). The upper forks of the Broad Hollow drainage include Edlridge Hollow and Pin Hollow. A small area in the southernmost portion of the West Lease drains directly to Quitchupah Creek in Convulsion Canyon.

Quitchupah Creek in Convulsion Canyon flows eastward to the confluence with the North Fork of Quitchupah Creek approximately 4 miles east of the Sufco Mine surface facilities area. Quitchupah Creek flow into Muddy Creek near Interstate 70, approximately 9 miles southeast of the confluence with the North Fork.

11.0 Determination of Probable Hydrologic Consequences

The following section describes the Determination of Probable Hydrologic Consequences of Coal Mining in the West Lease at the Sufco Mine.

728.100 Quality and quantity of surface water and groundwater under seasonal flow conditions

Information on Quantity and quality of surface-water and groundwater under seasonal flow conditoins in the West Lease and surrounding areas is presented in Table 2. Additional information on groundwater and surface-water quality and quantity in and around the West Lease has been submitted electronically to the Utah Division of Oil, Gas and Mining through the on-line coal water quality database, which is freely accessible and located at: http://ogm.utah.gov/coal/edi/wqdb.htm. Stiff diagrams graphically depicting the solute chemical compositions of groundwaters and surface-waters in the West Lease and surrounding areas are presented in Figure 6. Average concentrations of groundwater discharging from springs and surface waters in streams in and around the West Lease area are presented in Table 6. Discharge and water level hydrographs for groundwater and discharge hydrographs for surface waters in the West Lease and surrounding area are presented in Figures 7 and 8.

Groundwater in the North Horn Formation (monitored at spring Sufco 057A) is of the calcium-bicarbonate geochemical type, with an average TDS concentration of 322 mg/L (Table 6). Discharge from the North Horn Formation at Sufco 057A is highly influenced by climatic variability, with discharge typically occurring only in wet years (Figure 7b; Table 2).

Groundwater in the Price River Formation, as monitored at Mud Spring and Lizonbee Springs (GW-8 and GW-9) has an average TDS concentration that is more than two times that of the overlying North Horn Formation (749 mg/L; Table 6). Price River Formation groundwaters monitored in the West Lease and surrounding areas are of variable solute composition. Mud spring is of the calcium-sulfate geochemical type, with substantial concentrations of magnesium and bicarbonate (Table 2). Spring GW-8 is of the no-dominant-ion geochemical type, with elevated concentrations of sodium, calcium, bicarbonate, and sulfate. Spring GW-8 is of similar composition, but with somewhat elevated sodium concentration relative to calcium and magnesium, suggesting that ion-exchange has occurred (Figure 6; Table 2). Discharge from the Price River Formation Lizonbee Springs (GW-8 and GW-9) show seasonal variation, with the largest flows occurring during the springtime (Table 2; Figure 7).

Groundwater in the Castlegate Sandstone is of the calcium-bicarbonate or calcium-magnesium-bicarbonate geochemical type with an average TDS concentration of 264 mg/L (Table 6). It is noteworthy that the average TDS concentration of groundwaters from the Castlegate Sandstone are 2.8 times lower than the TDS concentrations from springs in the overlying Price River Formation (Table 6). Groundwater sampled at Broad Hollow Spring is of the calcium-bicarbonate geochemical type with a TDS concentration of 195 mg/L. It is noteworthy that conspicuous iron staining and deposition at the Broad Hollow Spring has been noted during most of the monitoring events at that spring. When the Broad Hollow Spring was analyzed for total and dissolved iron and manganese on 10 May 2010, significant concentrations of these species were measured in the water (Table 2). The total iron concentration measured at that time was 9.01 mg/L, while the dissolved iron concentration was 1.63 mg/L. The total manganese concentration was 1.165 mg/L, while the dissolved manganese concentration was 1.103 mg/L. On that date, the water sample collected was distinctly yellowish-orange in color and copious amounts of iron staining were noted at the site, as were bluish surface sheens on puddled water in and around the spring discharge area.

Discharge from the Castlegate Sandstone East Spring (Sufco 001) and water sampled from Castlegate well US-80-2 are of the calcium-magnesium-bicarbonate geochemical type and show little seasonal variation in water quality (Table 2). Groundwater sampled from these sources is elevated in TDS relative to that from Broad Hollow Spring (East Spring average TDS = 306 mg/L). Discharge rates at East Spring show responses to climatic variability. However, pronounced responses in discharge rates to seasonal recharge variability at East Spring are generally not observed. During 1977, discharge from East Spring was measured at 1.6 gpm. Subsequently, the discharge at the spring gradually increased, until reaching a peak of 7.32 gpm during 1984, which was an extremely wet spell. Subsequent to 1984, the discharge gradually declined through the late 1980s and early 1990s until stabilizing around 0.5 to 1 gpm since 1994. A conspicuous increase in discharge (3.59 gpm) occurred during 1997, at which time the region was transitioning to a wet spell which persisted until the end of the 1990s. The gradual long-term changes in discharge rates at East Spring suggest a highly buffered groundwater system with a large storage capacity (e.g. approximately 9 years passed from the time of peak discharge associated with the extreme wet spell of the early- and mid-1980s until the discharge rate returned to levels consistent with the earlier, dryer climatic cycle in 1977. Similarly, other than the response to the wet cycle in the late 1990s, the discharge since about 1994 has remained relatively constant. This may indicate that the groundwater system that supports East Spring has not fully recharged since drying out in the late 1980s (the climate conditions at the nearby Salina 24E station have for the most part been drier than normal for the past 10 years). Consequently, discharge at East Spring may increase at a time in the future when a sustained wet spell persists in the region for a period of time long enough to allow complete recharge the groundwater system. As the region near the spring was undermined during the early 1980s, it is possible that a component of discharge from the spring may have been translocated as a result of the mining operations. However, the elapsed time between the undermining of the spring area in the early 1980s and the generally lower flow rates at the spring that were first observed in the mid 1990s seems inconsistent with potential mining-related impacts. East Spring (Sufco monitoring site 001) will continue to be monitored in conjunction with mining in the West Lease.

Discharge of groundwater from the Blackhawk Formation to springs and seeps, or as baseflow discharge to streams has not been observed in the West Lease area. However, inactive-zone groundwater from the Blackhawk Formation is routinely encountered in the underground Sufco Mine workings. Discharge from the Blackhawk Formation to the mine workings does not show any seasonal variability in discharge rate. Rather, discharge from Blackhawk Formation sandstone paleochannels into the mine workings is typically short-lived, with discharge rates declining rapidly after first being encountered. This is consistent with the inactive-zone origins of the ancient water in the Blackhawk Formation and demonstrates the hydraulic isolation of these waters from shallow, seasonal recharge sources. A further characterization of groundwater quantity and quality in the Blackhawk Formation within the Sufco Mine is presented by Mayo and Associates (1997, 1999).

Star Point Sandstone groundwater, as monitored at spring Sufco 047 is of the calcium-magnesium-bicarbonate chemical type, with TDS concentrations averaging 479 mg/L. It is noteworthy that the temperature of discharge from this spring is elevated, averaging 27.4 °C. Neither the chemical composition nor the discharge rate from this Star Point Sandstone spring show significant seasonal variability, which is reflective of the ancient origin and deep bedrock source of this water. The elevated discharge temperature from this spring is likely a result of local near-surface burning of the coal seam around the outcrop, which has elevated the temperature of the aquifer host rock in burned areas.

728.200 Baseline hydrologic information

Spring and seep inventories have been conducted previously in the West Lease area in conjunction with previous permitting actions at the Sufco Mine. As part of this investigation, a supplemental spring and seep inventory was performed by Petersen Hydrologic, LLC, commencing in the fall of 2007. Subsequent to the spring and seep inventory, additional baseline monitoring activities on selected spring and stream sites in the West Lease area have been performed by Petersen Hydrologic, LLC. As part of the spring and seep surveys and baseline monitoring activities, groundwater and surface-water discharge rates and field water- quality parameters, including water temperature, pH, and specific conductivity, were measured. Additionally, monitoring of several spring, stream, and monitoring well locations in and around the West Lease area have previously been performed by Canyon Fuel Company and their hydrologic consultants. Additional monitoring of springs, streams, and wells was performed previously by the United States Geologic Survey (Thiros and Cordy, 1991) as part of a hydrologic reconnaissance of the Quitchupah and Pines areas. The results of the baseline monitoring activities at the West Lease area are presented in Table 2. Additional baseline hydrologic data for the West Lease area have been submitted electronically to the Division of Oil, Gas and Mining Coal Water Quality Database, which are available on line at: http://ogm.utah.gov/coal/edi/wqdb.htm.

728.310 Whether adverse impacts may occur to the hydrologic balance

The hydrologic balance is the sum of the flow interactions between surface waters and groundwaters and between various groundwater flow systems. This section describes the potential for adverse impacts to the hydrologic balance as a result of coal mining activities in the West Lease.

For reasons described in previous sections of this report, the potential for the establishment of hydrodynamic communication between the shallow, active-zone groundwater systems that support spring and seep discharges in the West Lease area and the deep, inactive-zone groundwater systems that will likely be encountered in the underground mine workings of the Sufco Mine is considered remote. Accordingly, while the deep inactive-zone groundwaters held primarily in sandstone paleochannels immediately overlying the mined coal seam will be dewatered through mining activities, it is considered highly unlikely that surface waters or shallow groundwaters could migrate from the near surface into the underlying mine workings where the depth of cover exceeds several hundred feet (which includes all proposed mining areas in the West Lease).

Active-zone groundwater systems in near-surface sediments and strata in the Price River and North Horn Formations, where overburden thicknesses are greater than about 800 feet should not be impacted by mining operations. This conclusion is based on the following lines of evidence:

1) The Price River and North Horn Formations are known to contain abundant and relatively thick shale and claystone layers. These low-permeability layers inhibit the vertical migration of groundwater into deeper strata. Additionally, the Mesa Verde Group shales and claystones in the region are known to contain hydrophyllic clays which are of low permeability and swell when wetted to effectively seal subsidence cracking.
2) While surface cracking in these formations (which typically extend less than about 50 feet below the land surface) can occur as a result of subsidence, the presence of uncompromised shale or claystone layers beneath the subsidence cracked zone prevents further downward migration of groundwater into deeper formations. Additionally, unconsolidated soils and weathered shales and clays are known to be present in North Horn- and Price River-derived sediments regionally. In areas where these formations are present near the surface and where tension cracking may occur, the tension cracks would likely remain open for only short periods of time. This is because the weathered or unconsolidated clayey or shaley sediments derived from these formations are typically plastic in nature and of low-permeability. These materials, through infilling or in-place swelling, tend to rapidly heal all but the largest tension cracks, minimizing impacts to local groundwater flow regimes.

> That this is the case is supported by decades of previous experience in the Wasatch Plateau and Book Cliffs coal districts of Utah, where literally hundreds of springs discharging from these formations that have been undermined without perceptible or quantifiable impacts occurring to groundwater and surface-water quality or quantity.

It should be noted that, while the downward migration of shallow groundwater into deeper geologic formations is unlikely to occur, the potential exists for the moving of groundwater discharge locations at the surface. Occasionally, where near-surface tension cracking is extensive, spring discharge locations may be moved to locations a few to several tens of feet topographically lower than the original spring discharge location. For example, if a low-permeability perching layer upon which groundwater was flowing toward a spring were to be compromised as a result of extensive tension cracking, the discharge previously flowing to the spring could be rerouted through the fractured perching layer downward until a lower uncompromised perching layer was present. Under this scenario, the post-mining discharge location for the spring would likely occur where the lower perching layer first intersected the ground surface in a down-dip location.

Recent experience at the Pines area at the Sufco Mine has shown that shallow bedrock groundwater systems in the Castlegate Sandstone may be impacted where subsidence fractures intercept shallow groundwater flow paths or discharge locations (Petersen Hydrologic, 2009). In the Pines area, the discharge to the surface at some Castlegate Sandstone springs was interrupted. Where this occurrence was noted in the East Fork of Box

Canyon Creek, discharge from three spring areas ceased at the surface (EFB-12, EFB-13, and EFB-14). However, within a short period of time, new groundwater discharge locations were observed on the hillside a few tens of feet stratigraphically lower than the original spring discharge locations. It is our opinion that the newly observed seepage locations lower on the hillside are discharge from the same groundwater system from which the three springs previously discharged. It is noteworthy that the total yield from the drainage basin, as measured at the confluence of the East Fork of Box Canyon with the main fork of Box Canyon Creek, was essentially unchanged relative to that of the pre-mining condition (Petersen Hydrologic, 2009). This provides evidence that, while the surface discharge locations for the Castlegate Sandstone springs were altered, the overall hydrologic balance in the drainage was not adversely impacted (i.e. the Castlegate Sandstone groundwaters were not drained into the mine workings or translocated out of the drainage basin).

Similarly, when Castlegate Sandstone springs in the North Water Canyon tributary to the East Fork of Box Canyon were undermined and subsided, discharge to the surface from three springs was interrupted (North Water Spring, Pines 310, and Pines 311 lower). Subsequent to undermining, significant subsidence cracking was observed at the surface near each of these springs and discharge to the surface from these springs soon ceased. It is our professional opinion that the mechanism whereby discharge from these springs was interrupted is similar to that whereby the East Fork of Box Canyon springs (springs EFB-12, 13, and 14) were affected. However, because of the thick cover of alluvial deposits in the canyon, and the gentle slope of the canyon bottom, the intersection of the lower, post-mining perching layer does not intersect the land surface in North Water Canyon. Accordingly, the groundwater that previously discharged from North Water Spring, Pines 310 and Pines 311 lower, likely now discharges at a down-dip location further horizontally removed from the original spring locations, where the lower perching layer intersects the land surface. The most likely location for this discharge is in the East Fork of Box Canyon, where discharge likely occurs as bed and bank seepage to the creek. As noted previously, the lack of appreciable change in the total yield from the East Fork of Box Canyon drainage subsequent to its undermining provides strong evidence that the spring discharge previously discharging in North Water Canyon has been translocated, and has not been diverted from the drainage basin or rerouted to the mine workings. Thus, while some groundwater discharge locations were changed after mining in the area was complete, the overall hydrologic balance in the drainage basin remained unchanged.

It is interesting to note that while the discharge locations of some springs were moved as a result of subsidence of the drainage, several other springs in and around the subsided areas of the East Fork of Box Canyon were not affected by the undermining of the drainage. This observation suggests that the movement of some spring discharge locations was a local-scale phenomenon and not a regional change in the Castlegate Sandstone groundwater system in the drainage.

Based on Sufco's previous experience undermining Castlegate Sandstone springs (that discharge where the formation is exposed at the surface and is susceptible to near-surface tension cracking) it is concluded that there is a potential for the translocation of Castlegate Sandstone spring discharge locations in the West Lease if these springs were to be undermined and subsided. Based on spring and seep survey information, it is apparent that the only such Castlegate Sandstone spring in the West Lease is Broad Hollow Spring (Figure 2). This spring discharges at low rates (<0.25 gpm) from near the base of the Castlegate Sandstone in the Broad Hollow/Pin Hollow area. If this spring or its shallow flowpath region were to be directly undermined and subsided, there would be significant potential for impacts to discharge rates from the spring (i.e., the groundwater currently discharging from the spring could potentially be diverted to a lower-elevation discharge location some distance removed from the current spring location). However, based on Sufco's proposed mine plan, this spring is planned to be avoided and is not to be undermined and subsided (See Plate 5-10 in the Sufco Mine MRP). Consequently, impacts to Castlegate Sandstone springs in the West Lease are not anticipated.

It has been suggested by some that impacts to discharge rates at spring Sufco 057A in Duncan Draw have occurred historically as a result of coal mining at the Sufco Mine. However, the results of this investigation strongly suggest that mining-related impacts to discharge at the spring have not occurred, nor are they likely to occur as a result of future mining in the West Lease. Staff at the Utah Division of Oil, Gas and Mining have also previously concluded that there is no clear connection between past mining at the Sufco Mine to the east and the drying of springs in the Duncan Draw, Mud Hollow area (DOGM, 2005).

The location of Duncan Draw spring Sufco 057A, which discharges from the North Horn Formation at an elevation of approximately 8,870 feet, is plotted in Figure 10. The bedrock strata in the area dip to the north-northwest at approximately 1.5 degrees. The locations of previously mined areas at the Sufco Mine and proposed future nearby mining locations are also plotted on Figure 10. Figure 10 includes a delineation of the entirety of the contiguous region surrounding the spring that is greater than 8,870 feet in elevation. The recharge location for spring 057A must of necessity be greater than 8,870 feet in order to develop the driving hydraulic head necessary to support discharge at the spring. Because the contiguous upland area surrounding the spring is bounded by canyons and other eroded areas that are topographically lower than 8,870 feet and which truncate the North Horn Formation strata, it is not physically possible for recharge to the spring to occur in more distant locations (the potential for recharge at some distant location along a fault zone coupled with strong vertical upward gradients along a fault zone in the Sufco 057A area is considered an exceedingly unlikely eventuality, for which there is no physical evidence). In other words, the entirety of the groundwater system that supports spring Sufco 057A almost certainly lies somewhere within the shaded area on Figure 10. This conclusion is supported by the rapid response to seasonal and climatic variability at the spring, and the lack of any discharge from the spring during dry climatic cycles. These observations are consistent with shallow groundwater flow paths, a limited storage capacity in the groundwater system, and a potential groundwater recharge area of limited size, which is consistent with the small, mostly shallow area mapped as the likely recharge area for spring Sufco 057A.

Upon inspection of Figure 10, it is immediately apparent that previously mined areas at the Sufco Mine are situated more than ½ mile west of the nearest possible physical location of the groundwater system that supports Sufco 057A. Accordingly, there is no reasonably plausible mechanism whereby earlier mining activities at the Sufco Mine could have impacted the groundwater system that supports discharge at the spring. Similarly, because proposed future mining areas in the Sufco Mine are outside the shaded area (Figure 10), there is essentially no likelihood of potential mining-related impacts to spring Sufco 057A because the physical location of the groundwater system is outside the zone where mining-related subsidence could occur.

Mine workings in the West Lease will likely intercept primarily ancient, perched groundwater systems in sandstone channels in the mine roof. Groundwater inflows along fault zones that may be intercepted by the mine workings in the West Lease may also occur. Although it is never possible to predict with certainty the nature and magnitude of groundwater inflows that will be intercepted in a new coal mining area, based on the similarity of the geologic and hydrogeologic conditions at the West Lease to the existing Sufco mine area, it is considered likely that groundwater inflows in the West Lease will be short lived and of magnitudes similar to those encountered previously in the Sufco Mine. Mining operations will dewater these ancient, perched groundwater systems. However, because these systems are not in good hydraulic communication with the ground surface or shallow overlying active-zone groundwater systems, dewatering of the deep perched systems will likely have no impact on overlying groundwater or surface water regimes.

As discussed previously, inactive-zone groundwater systems in the Blackhawk Formation occur in isolated partitions that are not in good hydraulic communication with the land surface or shallow overlying active-zone groundwater systems that support springs and seeps. Therefore, it is likely that groundwater that will be intercepted in the Blackhawk Formation in the West Lease will be groundwater being removed from storage. Because inactive-zone groundwater systems are not in hydraulic communication with the land surface or shallow, active-zone groundwater systems, groundwater being removed from the Blackhawk Formation is likely not being replenished by recharge from adjacent or overlying groundwater systems or from infiltration of surface waters.

At any underground longwall coal mine, interruption and deformation of strata above longwall-mined areas has the potential to alter pre-mining groundwater flow conditions. The potential for this impact to occur in the West Lease is minimal. Rock mechanics equations have been developed that predict the height to which bedrock fracturing will likely extend above areas subsided by coal mines. In western coal mines, it is estimated that subsidence fractures commonly propagate upward approximately 30 times the height of the extracted coal (Kadnuck, 1994). Other researchers have estimated the maximum height of upward propagation of fracturing at 50 times the height of the extracted coal. Assuming a mining thickness of 10 feet, it would be anticipated that fracturing would extend upward for a distance of approximately 300 to 500 feet. Above this height, rock strata tend to flex rather than fracture. Differential ground subsidence can also result in the formation of tension cracks at the land surface, particularly above abutments, longwall panel ends, and longwall gate roads. Previous experience at the Sufco Mine indicates that these fractures commonly extend less than about 50 feet below the land surface. Thus, in the West Lease area, a sequence of several hundred feet of unfractured rocks will likely exist between the bottom of the shallow tension cracks near the surface and the top of the fractured zone above longwall mined regions. This sequence of low-permeability rock prevents the downward migration of active-zone groundwaters into the deeper subsurface. The presence of hydrophyllic clays in the fine-grained rocks of the Sufco Mine area effectively seal fractures that may form in the subsurface, preventing appreciable downward migration of groundwater.

Impacts to groundwater systems in the Star Point Sandstone, which underlie the coal seams to be mined in the Blackhawk Formation, are not anticipated. Springs discharging from the Star Point Sandstone (spring Sufco 047 and groundwater seepage areas related to Sufco 047A) are associated with fractures in the sandstone bedrock that are stratigraphically lower than the Upper Hiawatha Coal seam to be mined. As discussed previously, the Upper Hiawatha Coal seam is underlain by shaley lagoonal sediments that include the Lower Hiawatha Coal seam, which would isolate the Upper Hiawatha coal seam from the underlying Star Point Sandstone. Mayo and Associates (1997) indicate that there is no known or suspected hydrologic connection between in-mine groundwaters and groundwaters discharging from the Star Point Sandstone. We concur with this conclusion.

It should be noted that Lizonbee Springs are located approximately 0.8 miles west of the West Lease boundary (Figure 2). The springs discharge along the trace of a significant north-south trending fault zone that is present along the eastern margins of the valley (Figure 5). Displacement along this fault has also resulted in a topographic depression of the land surface along the eastern margin of the valley which resulted in the creation of Acord Lakes (Thiros and Cordy, 1991). The solute compositions of the Lizonbee Springs suggest that the springs discharge from the Price River Formation (Table 2). The fault associated with

Lizonbee Springs will not be intercepted or disturbed as a result of mining in the West Lease (Figure 5; See also Plate 5-10 in the Sufco Mine MRP). Additionally, as discussed previously, impacts to groundwater systems in the Price River Formation resulting from mining-related activities are considered unlikely. Accordingly, impacts to water quality or water quantity to Lizonbee Springs are not anticipated. Similarly, there is no known reasonably plausible mechanism by which the Acord Lakes area could be impacted from mining-related activities in the West Lease.

In summary, based on the characterization of groundwater and surface-water systems presented above, and on the proposed mining plan, no significant impacts to the overall hydrologic balance are anticipated as a result of mining in the West Lease.

728.320 Whether acid-forming or toxic-forming materials are present that could result in the contamination of surface water or groundwater supplies

In the general sense, acid- and toxic-forming materials in soil and rock disturbed by coal mining have the potential to impact groundwater and surface water quality. Mine discharge water from the Sufco Mine is routinely monitored for indicators of increased acidity (iron and pH) and toxic materials. Although the concentrations of iron in mine discharge water are occasionally elevated relative to springs in the region, mine discharge waters rarely exceed permitted discharge limits.

No new topsoil or waste rock piles are planned as a consequence of mining in the West Lease and no impact from acid- or toxic-forming materials is anticipated.

With the exception of modest quantities of pyrite or similar sulfide minerals, no significant quantities of any acid- or toxic-forming materials are believed to be present in the West Lease. Iron pyrite and other sulfide minerals are commonly present in western coal mines. The oxidation of pyrite, which occurs when the mineral is exposed to water and oxygen, releases H^+ ions (acid) into the mine water. The acid produced from pyrite oxidation temporarily lowers the pH of the water. However, the acid produced from pyrite oxidation is rapidly consumed by reactions with the carbonate minerals which are pervasive in the rocks associated with the coal fields of the Wasatch Plateau. Thus, acid mine discharge in mine discharge water does not occur. The iron released into the water from pyrite oxidation is readily precipitated as iron-hydroxide when it contacts oxygenated water.

Thus, the potential for acid-forming or toxic-forming materials to result in contamination of surface-water or groundwater supplies is believed to be minimal.

728.331 ***What impact the proposed coal mining and reclamation operation will have on sediment yield from the disturbed areas***

The sediment load of streams can potentially be affected as a result of erosion and sediment transport from disturbed areas. Canyon Fuel Company has implemented a rigorous and effective sediment control program that is designed to minimize the sediment yield from disturbed areas. This includes the use of sediment control fences, re-vegetation of previously disturbed areas, and the diversion of surface waters around disturbed areas. Runoff from disturbed areas is collected near source areas and diverted into sediment control ponds for retention and settlement of suspended solids before being discharged to natural drainages.

The West Lease coal reserves are planned to be accessed through new portals that are currently being constructed near the existing Sufco Mine surface facility area, where effective sediment control structures are currently in place. The sediment control plan is described in Chapter 7, Sections 7.2.8 and 7.3.2 of the Sufco Mine MRP. Details for the East Spring Canyon Surface Facilities are shown on Plate 5-2A. The East Spring Canyon Drainage Detail map is included in the MRP as Plate 7-6. No surface facilities or disturbances within the West Lease area boundary are proposed. Consequently, there is minimal potential for additional impacts resulting from coal mining activities in disturbed areas associated with mining in the West Lease.

728.332 What impact the proposed coal mining and reclamation operation will have on acidity, total suspended and dissolved solids and other important water quality parameters of local impact

As discussed previously, impacts to the water quality of active-zone groundwater systems that support springs and seeps in the West Lease area are not anticipated. Perennial or intermittent streams are not present in the West Lease area. Rather, surface waters in stream drainages in the West Lease are present only in response to snowmelt and torrential precipitation events. Because there is no groundwater-related baseflow component to discharge in the streams, the potential for impacts to water quality in these drainages as a result of mining-related activities is considered remote.

It should be noted that sediments in the Price River Formation, which exist at or near the surface over much of the West Lease area (Figure 5) are known to naturally contain appreciable amounts of soluble minerals. Interactions of surface waters in ephemeral drainages with Price River Formation sediments under existing pre-mining conditions can result in increased total dissolved solids concentrations. Mining-related activities in the West Lease are not expected to change the potential for interactions between ephemeral surface waters and Price River Formation sediments.

The potential for appreciable increases in sediment yield as a result of mining in the West Lease (that could result in elevated suspended solids concentrations) is minimal. Where differential subsidence of the land surface occurs in stream drainages, there is the potential for the temporary increase of sediment yield in these drainages. This potential impact is primarily the result of subsidence-induced gradient changes in stream channels in areas of differential subsidence. However, this effect is generally expected to be short lived. This is because the channel substrate in areas of increased stream gradients is down-cut while sediment is deposited in areas of decreased stream gradients and the stream gradually returns to equilibrium with its channel substrate.

Thus, detrimental impacts to important water quality parameters such as acidity, total suspended solids, and total dissolved solids in creeks and springs in the West Lease are generally considered unlikely.

It should be noted that in the event that subsidence fracturing of bedrock horizons beneath a stream or near the discharge location of a spring occurs, there is a potential of a modest, temporary increase in TDS concentration. This increase could result if the bedrock horizons fractured contained pyrite or other sulfide minerals. When subsidence-fractured rock surfaces expose pyrite to an aqueous, oxygen-rich environment, sulfide mineral oxidation may occur. Under such circumstances, some solutes, primarily sulfate, bicarbonate, calcium, and magnesium can increase. Such reactions typically do not occur in deep groundwater systems because of the lack of available oxygen in these systems. Because the pyrite is consumed by the oxidation reaction, the reaction ceases when all the freshly exposed pyrite is oxidized.

Such an occurrence was noted in a short reach of the East Fork of Box Canyon after the stream was undermined in 2003-2004 (Petersen Hydrologic, 2004). In that instance, the TDS concentration of water increased in the creek by 66 mg/L from 325 to 374 mg/L. When the stream reach was again visited in the spring of 2005, it was apparent that the oxidation reaction in the creek had ceased. The iron hydroxide deposits that had precipitated in the stream channel as a result of pyrite oxidation had been scoured from the channel and conditions in the stream appeared normal.

Fuels, greases, and oils are stored and used in the Sufco Mine permit area. There is the potential for spillage of these substances during equipment maintenance and operations, during filling of storage tanks and vehicle tanks, and from leakage from potentially leaking storage tanks.

The Sufco Mine has previously implemented a rigorous spill prevention plan that is designed to minimize the potential for spillage of these substances and to ensure that any potential spills that may occur are promptly cleaned-up. This plan will continue to be followed during mining in the West Lease. Because the West Lease reserves will be accessed from the permitted existing surface facilities area (including equipment maintenance and fueling areas and chemical storage areas), there should be no additional potential for spillage as a result of mining in the West Lease.

The discharge of Sufco Mine water to surface water drainages will have an impact on the water quality of receiving waters. The nature and magnitude of this impact is related to the relative quality of the receiving water and the mine discharge water. If the mine discharge water is of poorer quality than the receiving water, then the quality of the receiving water will be degraded proportionally. If the mine discharge water is of better quality than the receiving water, the quality of the receiving water will be improved. Historically, the discharge water from the Sufco Mine has generally been of relatively good quality and has usually met the beneficial use standards of the receiving water (DOGM, 2010).

Based on the fact that the geologic conditions at the West Lease are generally similar to those in the adjacent existing Sufco Mine permit area, it is anticipated that the character of groundwater inflows in terms of both quality and quantity will likely be similar to those that have historically occurred in the existing Sufco Mine. Consequently, no impacts to important water quality parameters above those that may occur at the existing Sufco Mine area are anticipated as a result of mining in the West Lease. The discharge of Sufco Mine water is regulated under a UPDES permit issued from the Utah Division of Water Quality.

728.333 What impact the proposed coal mining and reclamation operation will have on flooding or streamflow alteration

There are no known geologic features in the West Lease area that are substantively different than those that have been encountered elsewhere in the Sufco Mine (Personal communication, Mark Bunnell, 2010). Mining practices to be utilized in mining the West Lease will also be similar to those currently implemented at the Sufco Mine. Accordingly, it is anticipated that discharge rates from the Sufco Mine during mining in the West Lease will likely be of similar magnitude to those that are currently occurring. Thus, no significant increase to the flooding or streamflow alteration potential of Sufco Mine discharge water to Quitchupah Creek is anticipated above that currently occurring as a result of mining in the West Lease.

728.334 What impact the proposed coal mining and reclamation operation will have on groundwater and surface-water availability

It has been demonstrated that the active-zone groundwater systems that support springs and seeps in the West Lease area are isolated from the inactive-zone groundwater systems that will be encountered during mining in the West Lease. As noted above, were Castlegate Sandstone springs or their groundwater flowpath areas in the West Lease (such as Broad Hollow Spring) to be directly undermined and subsided, there is the potential for diminished discharge from these springs. However, no Castlegate Sandstone springs are to be undermined in the proposed mining plan. Also discussed previously, the potential for impacts to springs and seeps in the overlying Price River and North Horn Formations and in the underlying Star Point Sandstone is considered minimal. Therefore, the availability of these groundwaters and surface waters will likely not be impacted.

Current mining operations have made available several hundreds of gallons per minute of mine discharge water that has previously been unavailable for use. It is anticipated that as mining progresses in the West Lease, additional groundwater inflows into the mine workings will occur and discharge of groundwater to the Quitchupah Creek surface-water drainage will likely continue. It should be noted that the discharge of mine water at current discharge rates would likely not be sustained over a long period of time. Historically, discharge rates from individual inactive-zone mine inflows decline over time. This is because the inactive-zone groundwater is being removed from storage and is not being actively recharged. Rather, the rate of discharge from the mine is best correlated with the rate at which the mine workings are advanced into new mining areas, and not to the total cumulative footprint of the mine workings (Mayo and Associates, 1997). It should not be assumed that the groundwater discharging from the mine will be a long-term source of water.

728.350 Whether the underground coal mining and reclamation activities may result in contamination, diminution or interruption of State-appropriated water

It has been demonstrated that the active-zone groundwater systems that support springs and seeps in the West Lease area are isolated from the inactive-zone groundwater systems that will likely be encountered during mining activities. Accordingly, the potential for contamination, diminution, or interruption of groundwater systems resulting from draining of active-zone groundwaters into deep horizons (or the mine workings) is considered remote. As discussed in Section 728-310 above, if springs discharging from Castlegate Sandstone bedrock in the West Lease area were to be undermined and subsided, there is the potential for the translocation of groundwater discharge locations through subsidence cracks. However, as no Castlegate Sandstone springs are planned to be subsided in the West Lease area, this potential impact is not anticipated. Inactive-zone groundwater systems that will likely be encountered during mining in the West Lease include primarily perched systems associated with sandstone channels in the Blackhawk Formation. While deep, inactive-zone Blackhawk Formation groundwater systems will be intercepted and dewatered during mining activities, in the pre-mining condition, there are no known uses or State appropriations of these waters.

12.0 Recommended Monitoring Plan

The recommended monitoring plan for groundwaters and surface waters in the West Lease area is presented below. The purposes of the recommended groundwater and surface-water monitoring plan are to 1) document the effects of seasonal and climatic variability on groundwater and surface-water resources, 2) collect data to document that the shallow, active-zone groundwater systems in the West Lease area operate independently of the deep, inactive-zone groundwater systems encountered in the Sufco Mine, 3) to provide verification that mining-related impacts to groundwater and surface-water systems do not occur and 4) to determine the magnitude and character of any potential impacts to water quantity or water quality if such were to occur. The proposed monitoring sites are shown in Figure 11. The monitoring plan is summarized in Tables 7, 8, and 9, and is described below.

Springs

We recommend the monitoring of two springs in the West Lease area. These include Mud Spring, which discharges from the Price River Formation in Mud Spring Hollow, and Broad Hollow Spring, which discharges from the Castlegate Sandstone in the upper Broad Hollow/Pin Hollow area (Figure 11).

Mud Spring is a spring that has been developed for livestock watering use. An underground groundwater collection system has been installed with a connected spring box below the source area. Discharge from the spring is piped to adjacent troughs and stock ponds below the spring area. During the period of baseline monitoring at Mud Spring, flowing water was not observed from the spring. However, a stagnant pool of water in the partially buried spring box has been present on some occasions (with no outflow to the piping system). As part of the monitoring plan, discharge measurements at Mud Spring will be made by measuring the total discharge from the spring box through the piping system (at the first downstream location where a total discharge measurement is possible). Field water quality measurements will be made in the spring box (which is the access point closest to the natural spring location). The laboratory water quality sample will also be collected from the spring box when sufficient water is present to collect a representative groundwater sample.

Broad Hollow Spring, which is sourced from Castlegate Sandstone bedrock, discharges diffusively through fine-grained sediments in the bottom of Broad Hollow. The spring has been developed for stockwatering use. Discharge from Broad Hollow Spring is routed through a plastic pipe near the spring location to a stockwatering trough located lower in the hollow. The spring discharge area has been heavily impacted by livestock and the collection and piping system are currently in poor condition. Discharge measurements at Broad Hollow Spring will be performed by measuring the flow into the trough and also measuring the diffuse flow (if any) bypassing the collection system and flowing over the ground below the spring discharge area. The reported discharge value will be the sum of these two discharge measurements. Measurements of field water-quality parameters at Broad Hollow Spring will be performed as near to the spring discharge location as possible. Samples for laboratory water quality analysis will be collected from the pipe discharging into the trough when sufficient flow through the pipe is occurring. When there is not sufficient water flowing into the trough, the laboratory water quality sample will be collected from the diffuse discharge near the spring discharge area. It should be noted that because of the diffuse nature of the meager discharge at the spring, and the trampled ground surface in the discharge area, the collection of a representative sample of spring water from the discharge location can be problematic. When laboratory water quality samples are collected from the spring source area, care will be taken to collect the best sample possible.

We recommend that both of these springs be monitored quarterly for discharge and field water quality parameters. Impacts to water quality in these springs as a result of mining-related activities are not anticipated. However, to further document the chemical characteristics of groundwater from these springs, we recommend that these springs be monitored for laboratory operational water quality parameters for a period of two years. Subsequent to the two years of laboratory operational water quality monitoring, we recommend that these springs be monitored for discharge and field water quality parameters only. If significant changes to water quality are identified through the field water quality monitoring that could be attributed to mining activities, operational laboratory water quality monitoring will resume.

Streams

No perennial or intermittent streams are present in West Lease. Only ephemeral washes exist which rarely contain water. As described in the statement of probable hydrologic consequences above, the potential for impacts to water quality or water quantity in these ephemeral washes is considered negligible. Accordingly, no new stream monitoring stations are proposed in conjunction with mining in the West Lease. However, we recommend continued monitoring of stream monitoring stations Sufco 006 (South Fork Quitchupah Creek immediately north of the West Lease), Sufco 047A (East Spring Hollow/Mud Spring Hollow tributary to Quitchupah Creek below the Sufco Mine surface facilities), and Sufco 042 (Quitchupah Creek below the Sufco Mine discharge inflow), which are currently included in Sufco's approved monitoring plan. Sufco Mine discharge water is also routinely monitored (and will continue to be monitored) in conjunction with the mine's UPDES discharge permits.

Wells

We recommend the quarterly monitoring of water levels in monitoring well US-81-3, which is located on the eastern boundary of the West Lease (Figure 2). The well is screened in the Upper Hiawatha seam of the lower Blackhawk Formation. Potentiometric data from this well will assist in characterizing potential impacts to inactive-zone groundwater systems in the vicinity of proposed West Lease mine workings. It should be noted that this well has not been monitored since October 1997 and its current condition and suitability for monitoring is unknown. Additionally, this well may become inoperable and cease to provide meaningful data as mining in the West Lease approaches the well. Accordingly, we recommend the monitoring of this well for the time it is available for monitoring if conditions in the well prove suitable.

We also recommend that monitoring wells US-80-2 and US-81-4, which are located near the West Lease and are currently being monitored as part of Sufco's water monitoring plan, continue to be monitored in conjunction with mining in the West Lease.

Use of the Groundwater and Surface-Water Monitoring Plans

The purposes Sufco's groundwater and surface-water monitoring plans are to provide verification that mining-related impacts to groundwater and surface-water systems do not occur, and to determine the magnitude and character of potential impacts if they do occur. Comparisons between monitoring data (for the parameter of interest or concern) collected during baseline pre-mining conditions should be made with monitoring data (for the same parameter or interest of concern) collected during the operational and/or reclamation phase of mining to determine impacts. When changes to monitored parameters subsequent to mining in an area are observed in the monitoring data, an analysis of all data should be performed to determine the cause(s) of the change in the hydrologic condition. In utilizing the monitoring data to detect or quantify potential mining-related impacts, it is necessary to evaluate all factors relevant to the prevailing hydrologic conditions together with the monitoring data. This is because other factors, which are not related to the mining activity, may cause changes in the prevailing hydrologic conditions. In particular, climatic variability (which may result in increased or decreased groundwater and surface-water flow rates, changes in water levels in wells, and changes in water quality) should be carefully evaluated together with the monitoring data. Other factors that may influence coal mine hydrology include grazing practices, land use, and range condition. A convenient and useful means of evaluating regional climatic data is through the use of the Palmer Hydrologic Drought Index, which is a monthly value that indicates the severity of wet and dry spells that is generated by the National Climatic Data Center and available on-line at http://www1.ncdc.noaa.gov/pub/data/cirs/drd964x.phdi.txt.

The use of Stiff (1951) diagrams is a useful technique that is frequently used to analyze and compare groundwater and surface-water quality characteristics from various sources. Information required to create Stiff diagrams is available from the Division of Oil, Gas and Mining Coal Water Quality Database, which is freely accessible at: http://ogm.utah.gov/coal/edi/wqdb.htm. Additional information on coal mining hydrology and potential mining-related impacts, which can be use to assist in the evaluation of monitoring data and potential mining-related impacts is provided on the Utah Division of Oil, Gas and Mining web page at http://ogm.utah.gov/coal/water/default.htm.

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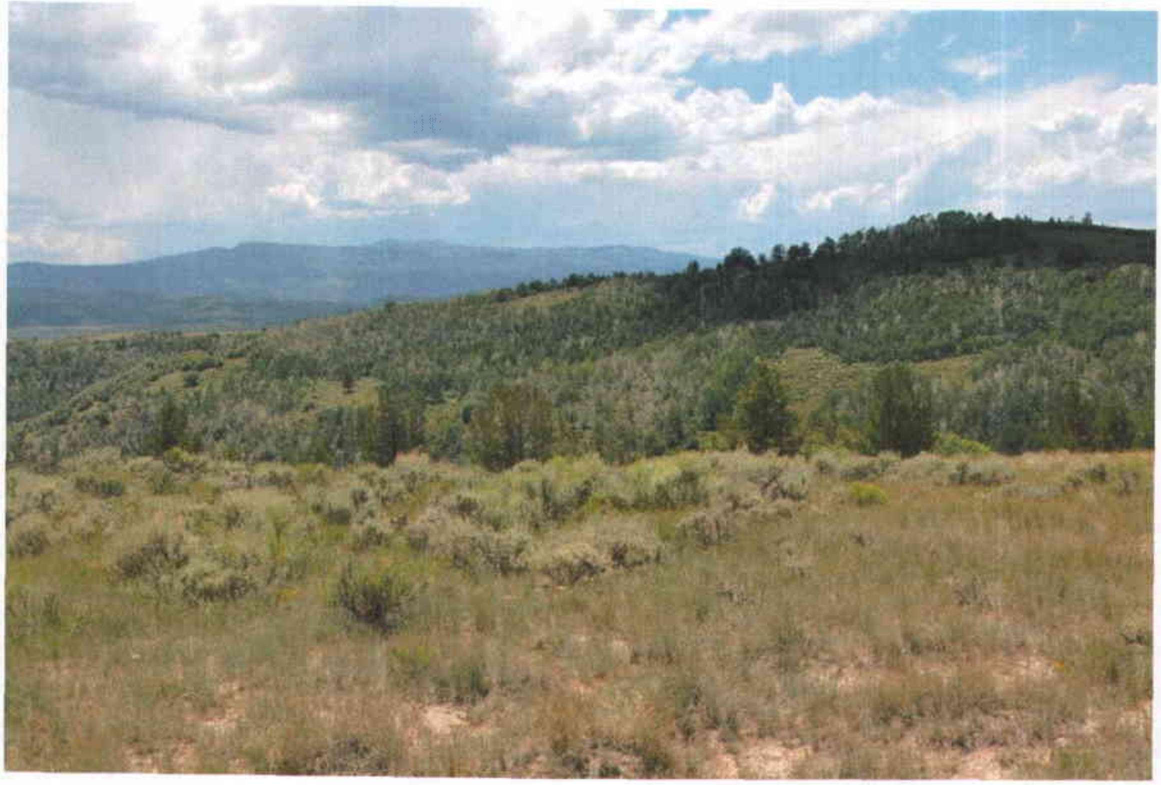
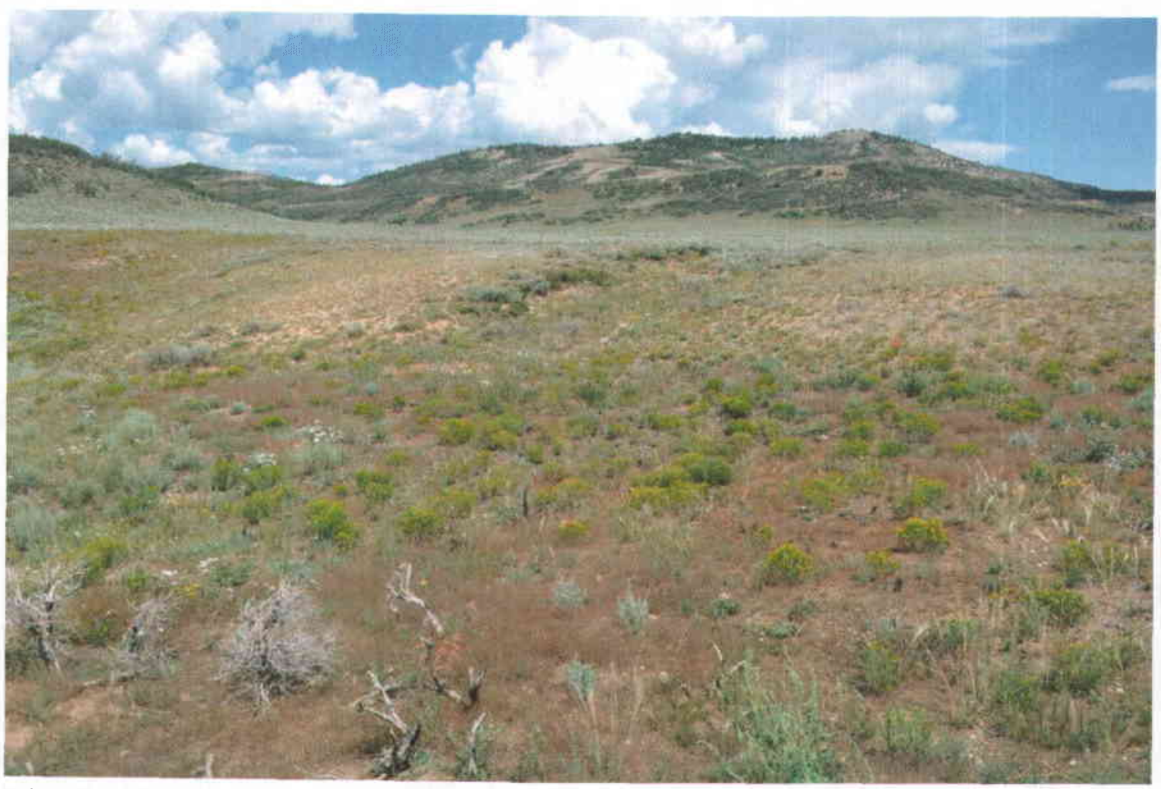


View looking west from Duncan Mountain toward Duncan Draw.



View looking north showing rolling plateau developed in the Price River Formation.

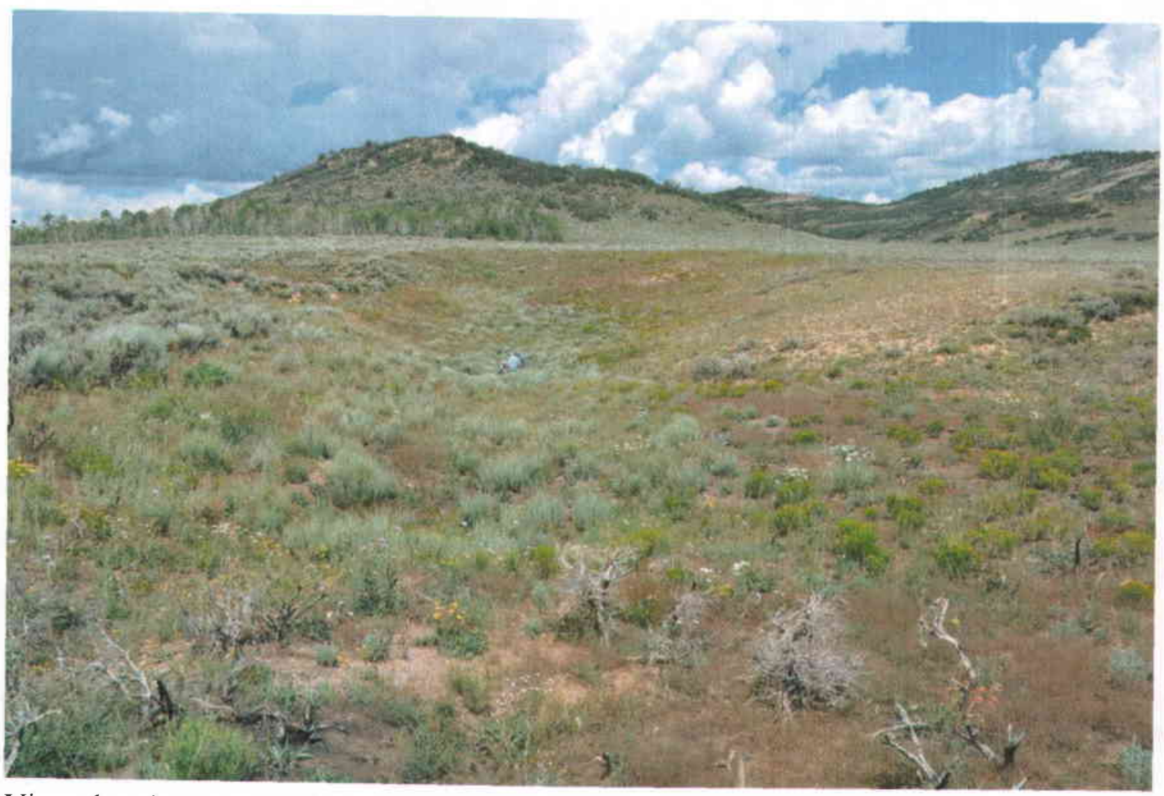

Mud Spring source area and spring box.


View looking down Mud Spring Hollow at Mud Spring.

Spring Sufco 057A, trough and source area.

Spring Sufco 057A source area.

View looking north along Mud Spring Fault Graben in Section 2, R4E, T22S.



View showing internal drainage in the Mud Spring Fault Graben.


Broad Hollow Spring trough.


Broad Hollow Spring source area.

East Spring (Sufco 001) source area.


Upper Mud Spring source area.

View looking north toward Lizonbee Springs (green areas on upper right side of valley).

View looking north at Acord Lake. Note fault scarp on right side of valley.

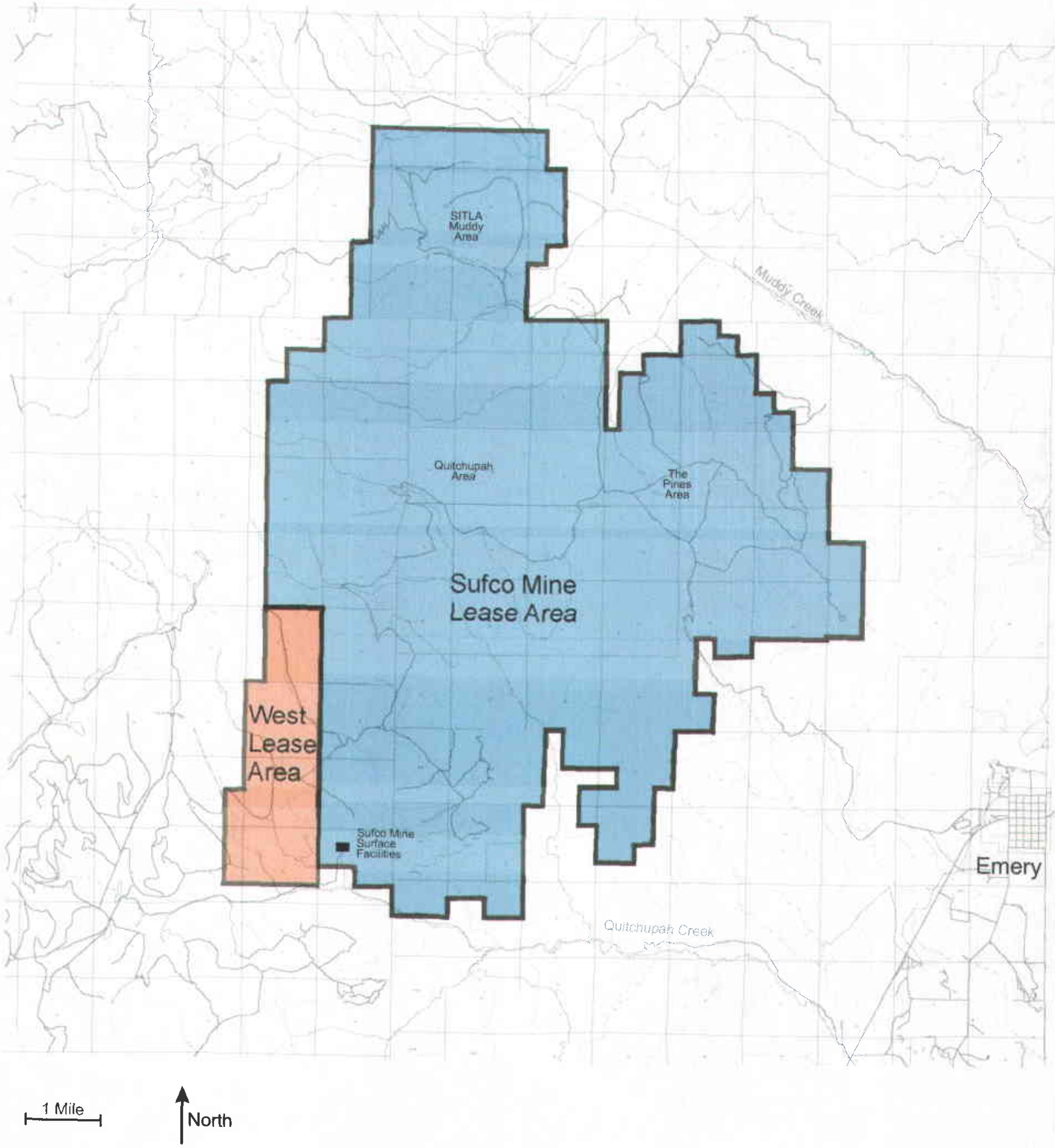


Figure 1 Location of Sufco Mine and West Lease areas.

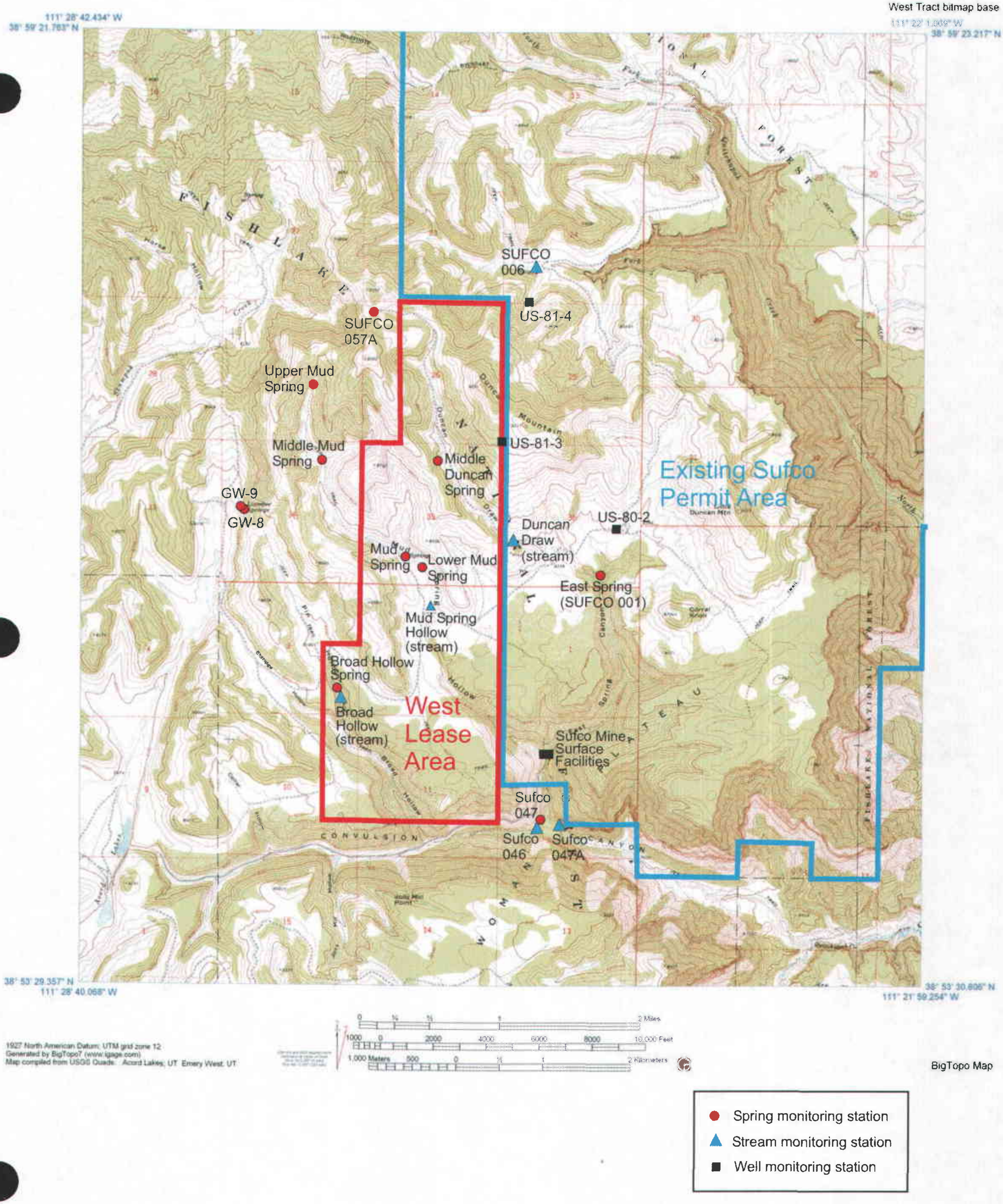


Figure 2 Baseline monitoring locations in the West Lease area.

Precipitation at the Salina 24E (Sufco Mine) Weather Station

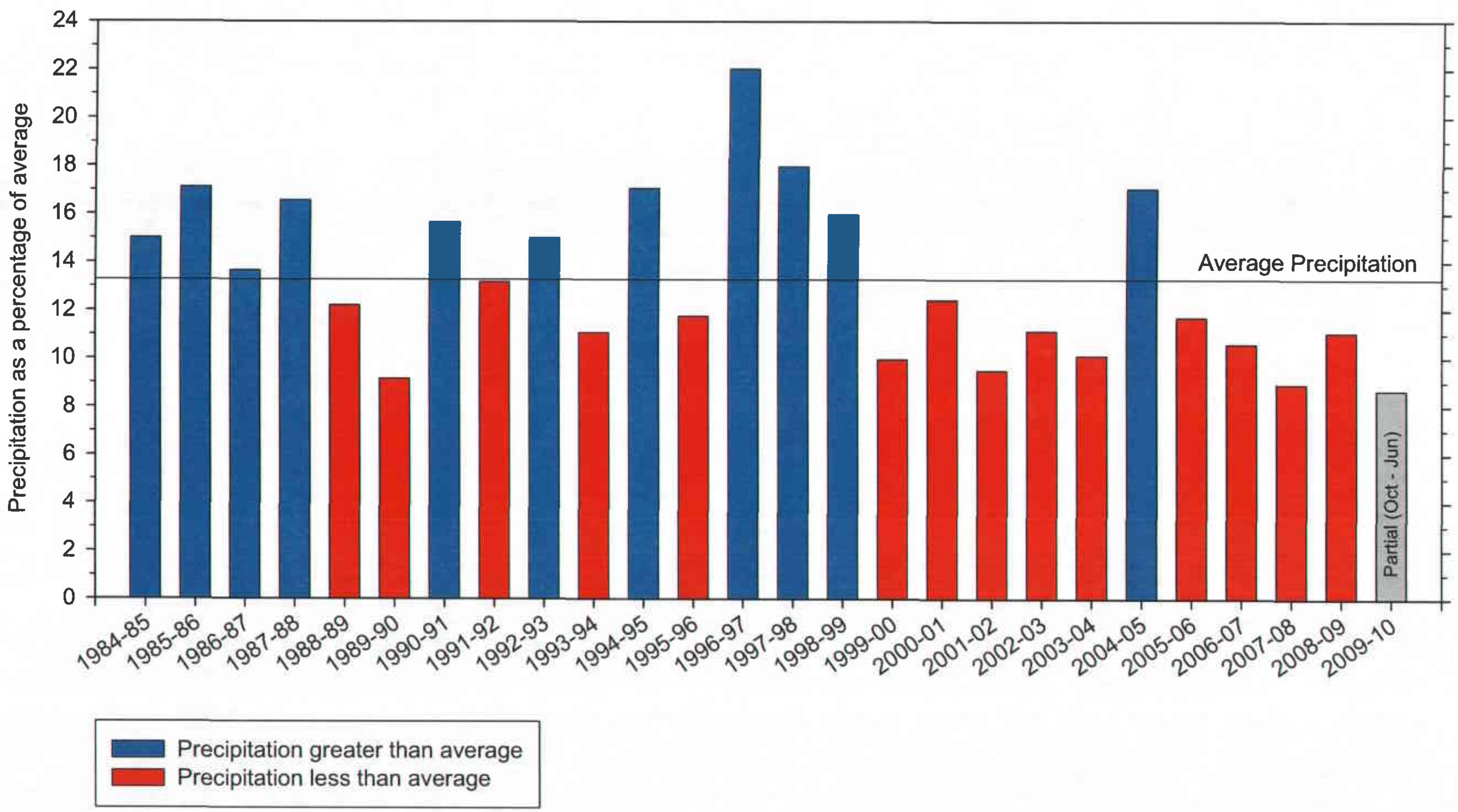
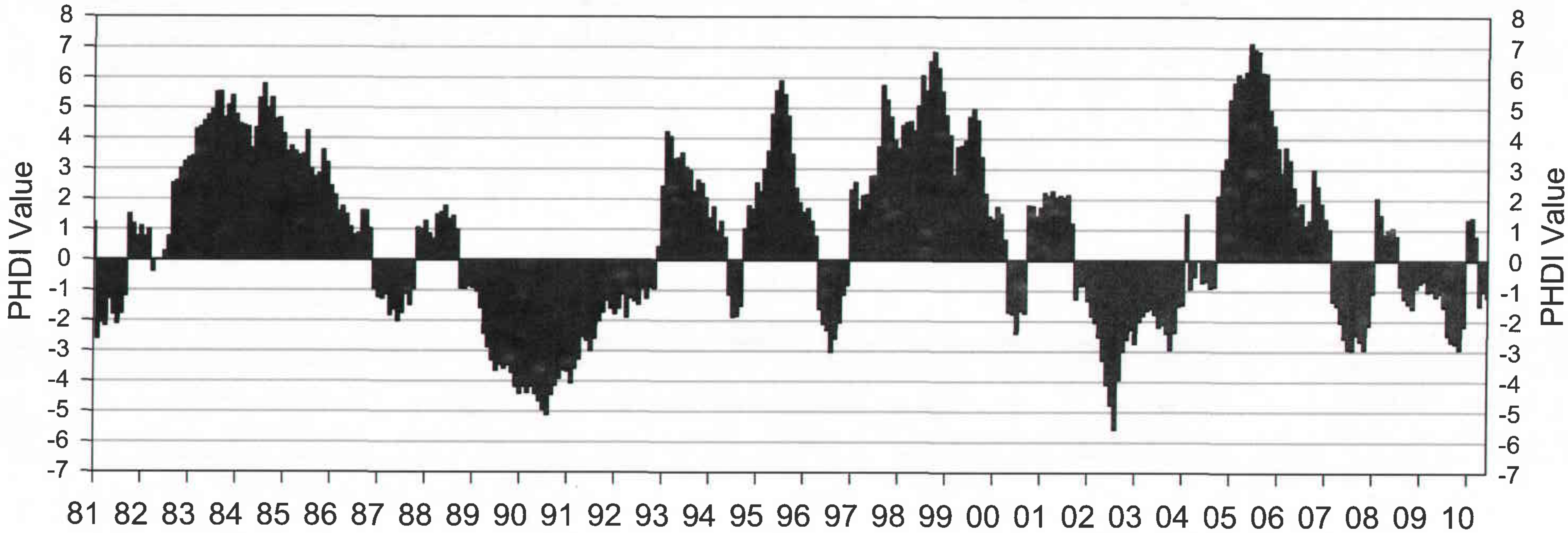


Figure 3 Precipitation Data for the Salina 24E (Sufco Mine) Weather Station.



-1 to -2	Mild Drought	1 to 2	Mild Wet Spell
-2 to -3	Moderate Drought	2 to 3	Moderate Wet Spell
-3 to -4	Severe Drought	3 to 4	Severe Wet Spell
-4 to -5	Extreme Drought	4 to 5	Extreme Wet Spell

Figure 4 Plot of Palmer Hydrologic Drought Index for Utah Region 4.

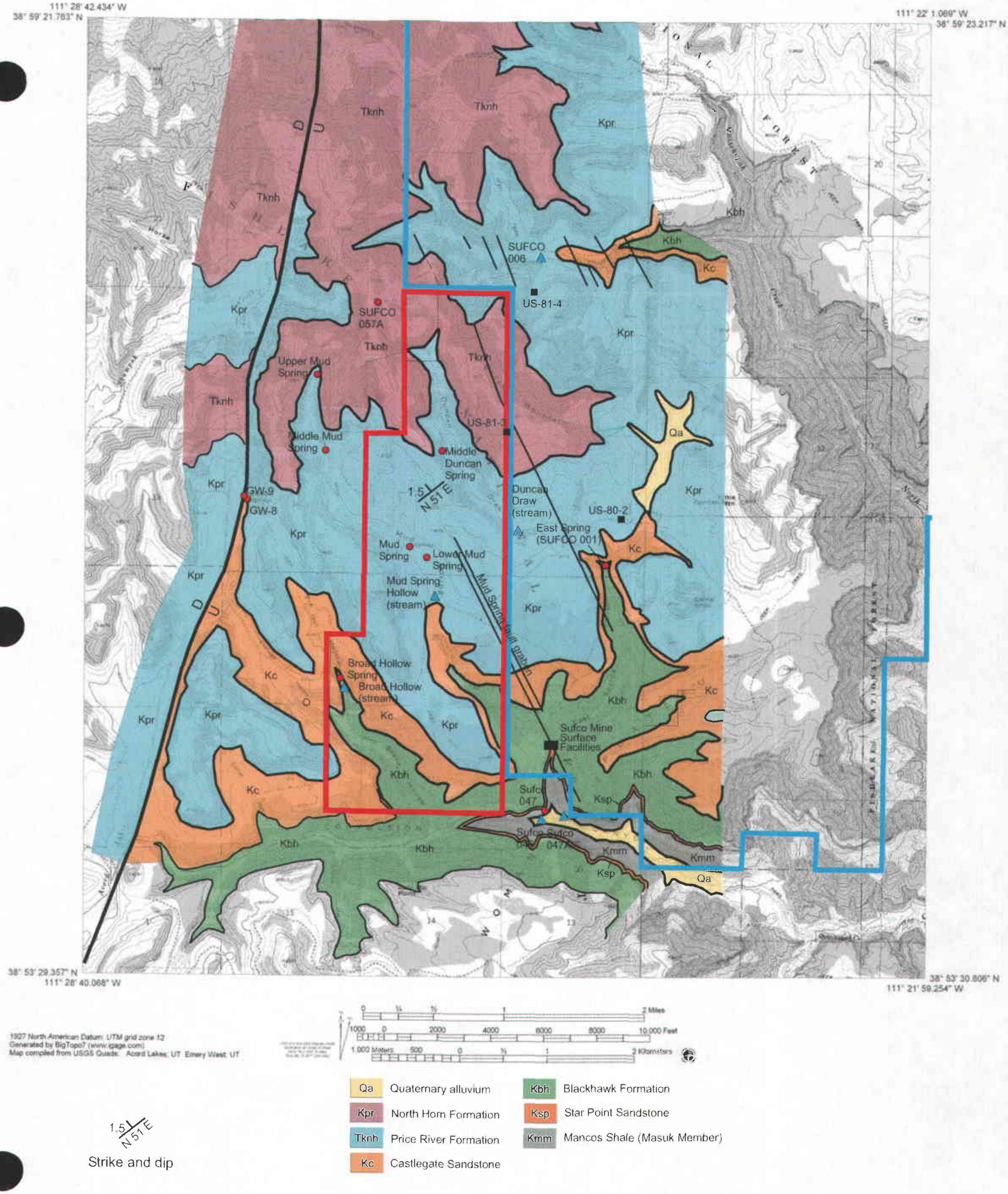


Figure 5 Geologic Map of the West Lease Modification area.

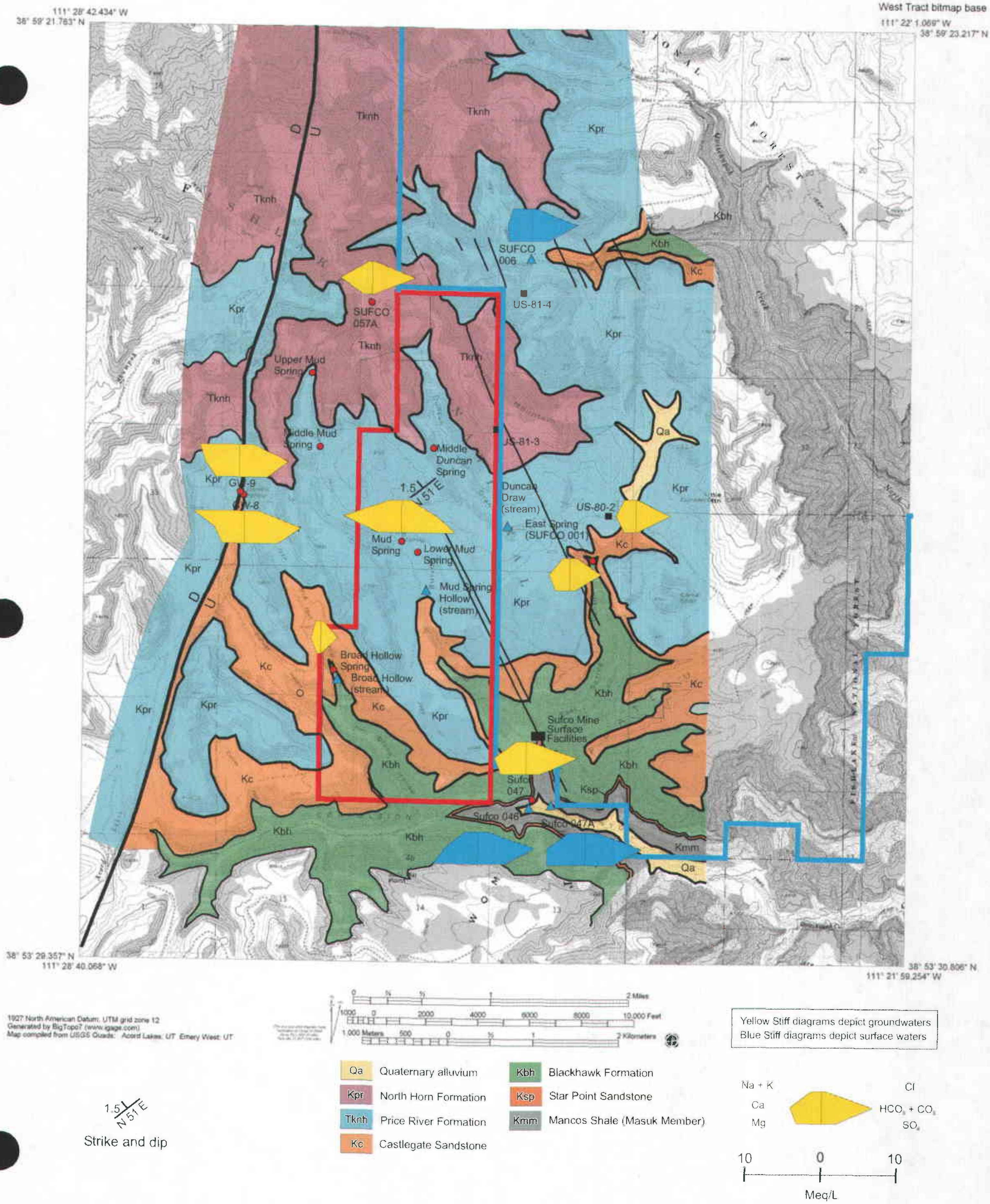


Figure 6 Stiff diagrams for groundwaters and surface waters in the West Lease area.

East Spring (Sufco 001)

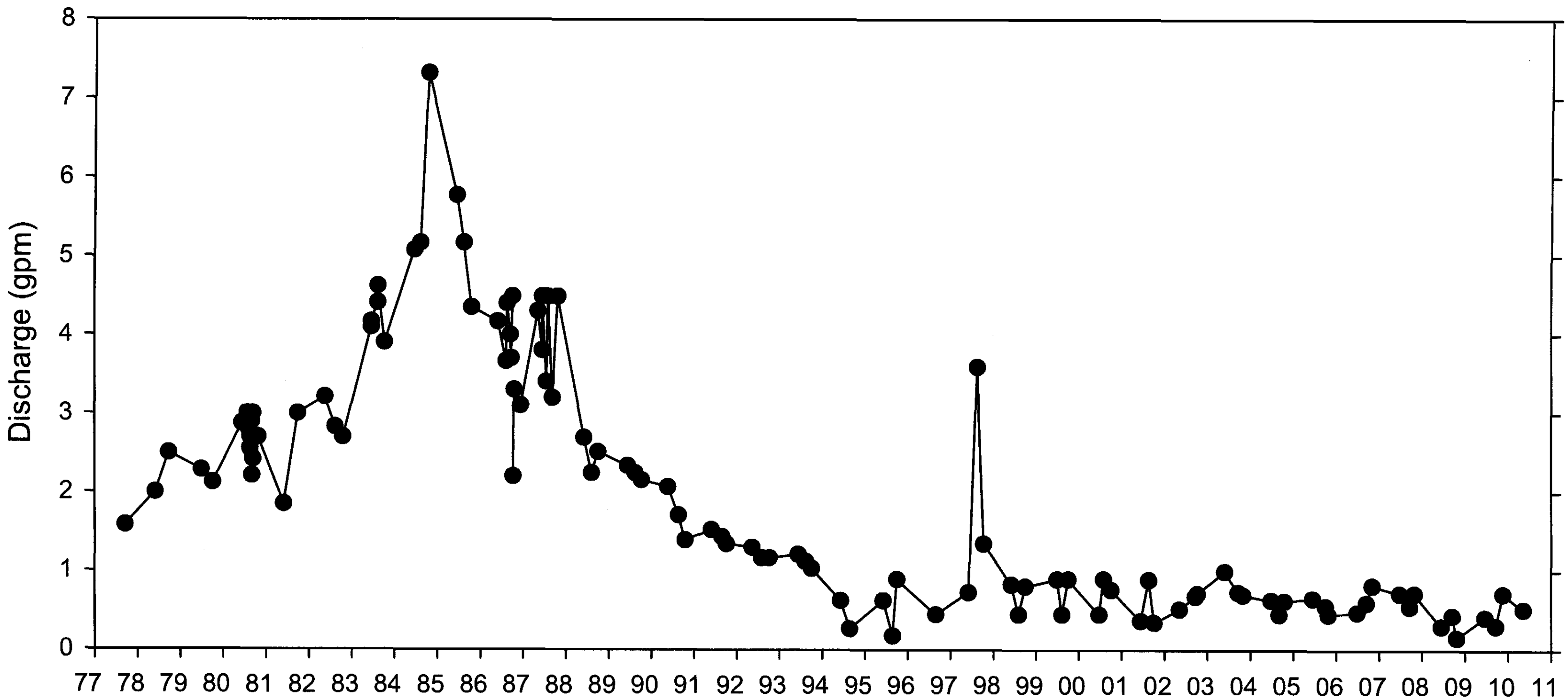


Figure 7a Discharge hydrograph for East Spring (Sufco 001).

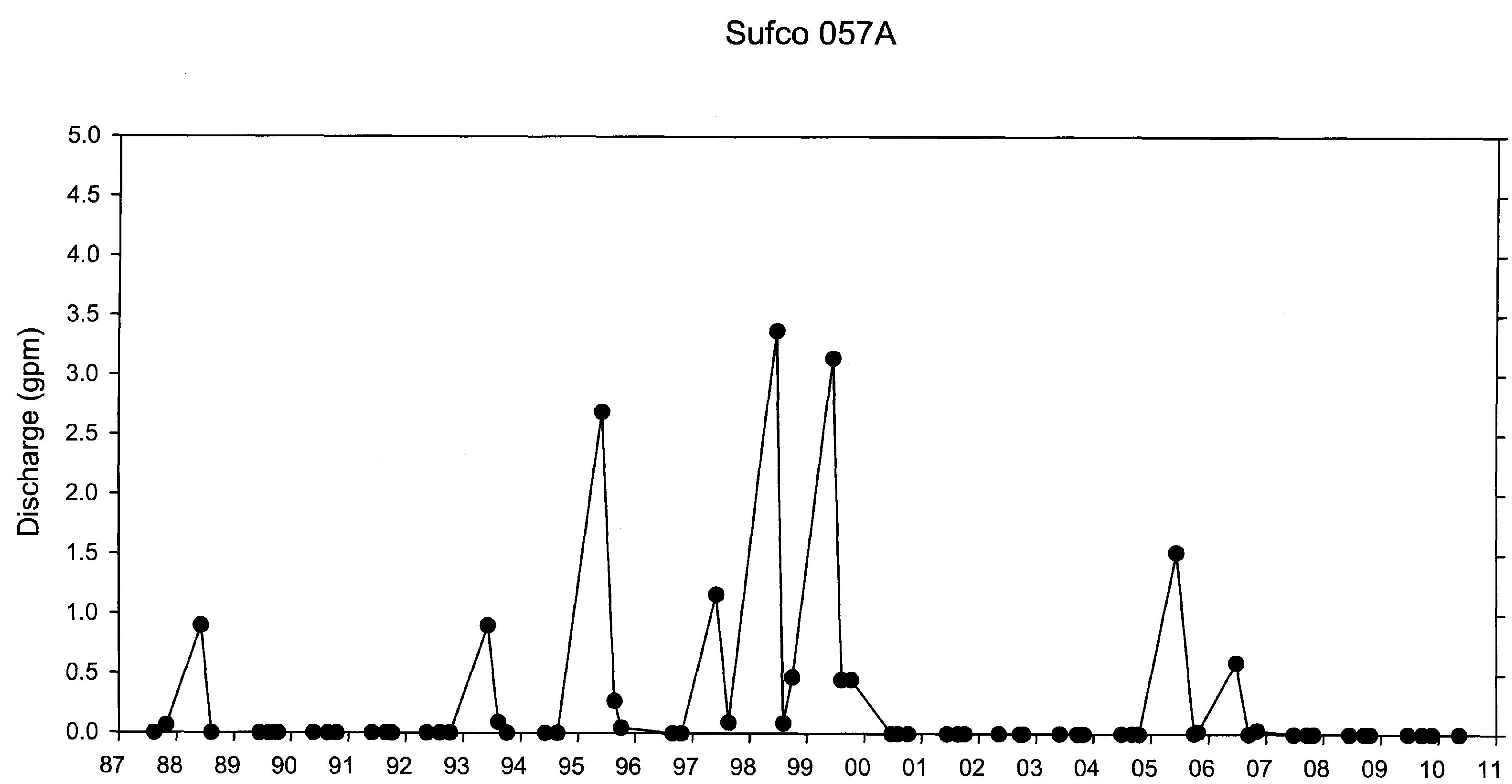


Figure 7b Discharge hydrograph for spring Sufco 057A in upper Duncan Draw.

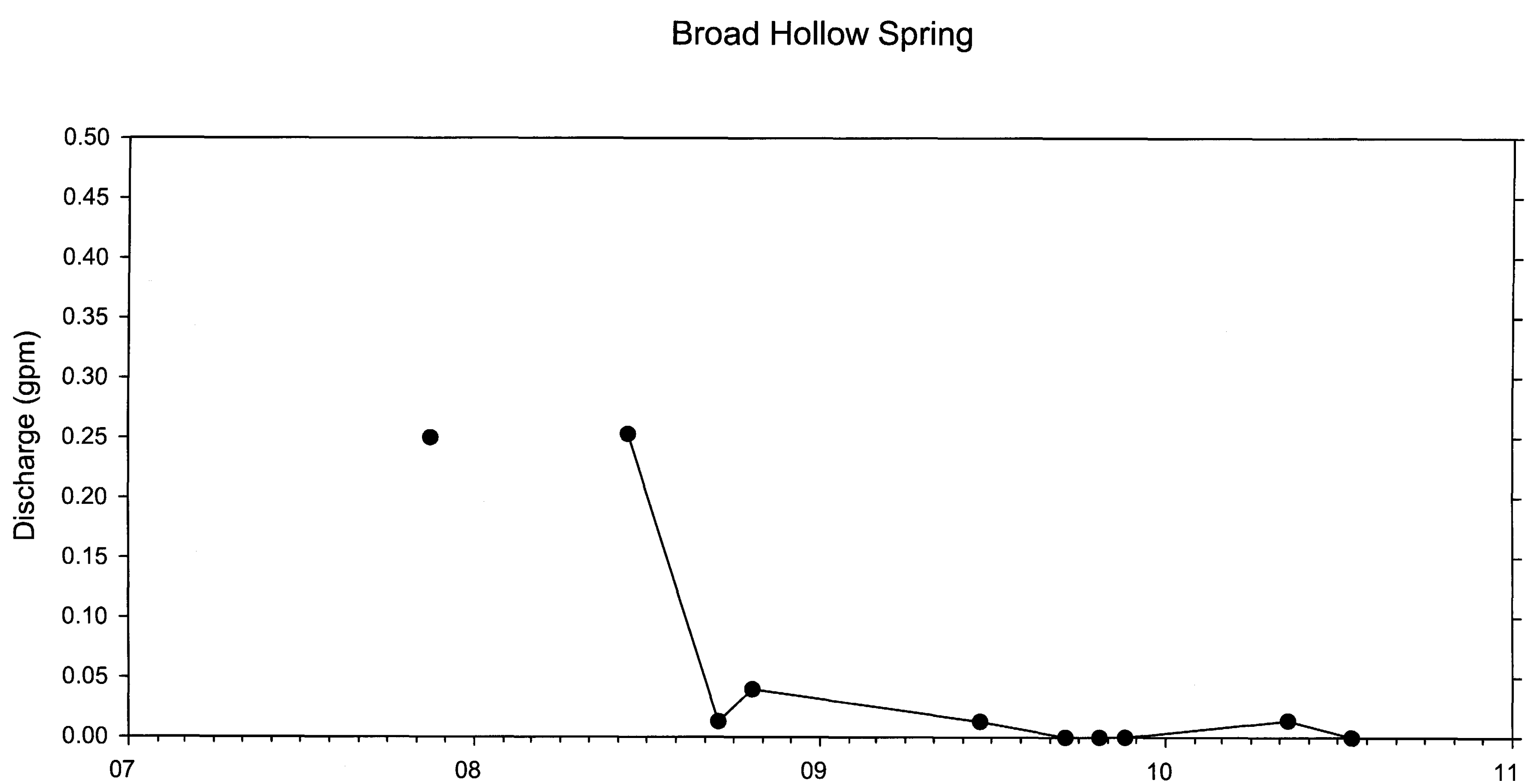


Figure 7c Discharge hydrograph for Broad Hollow Spring.

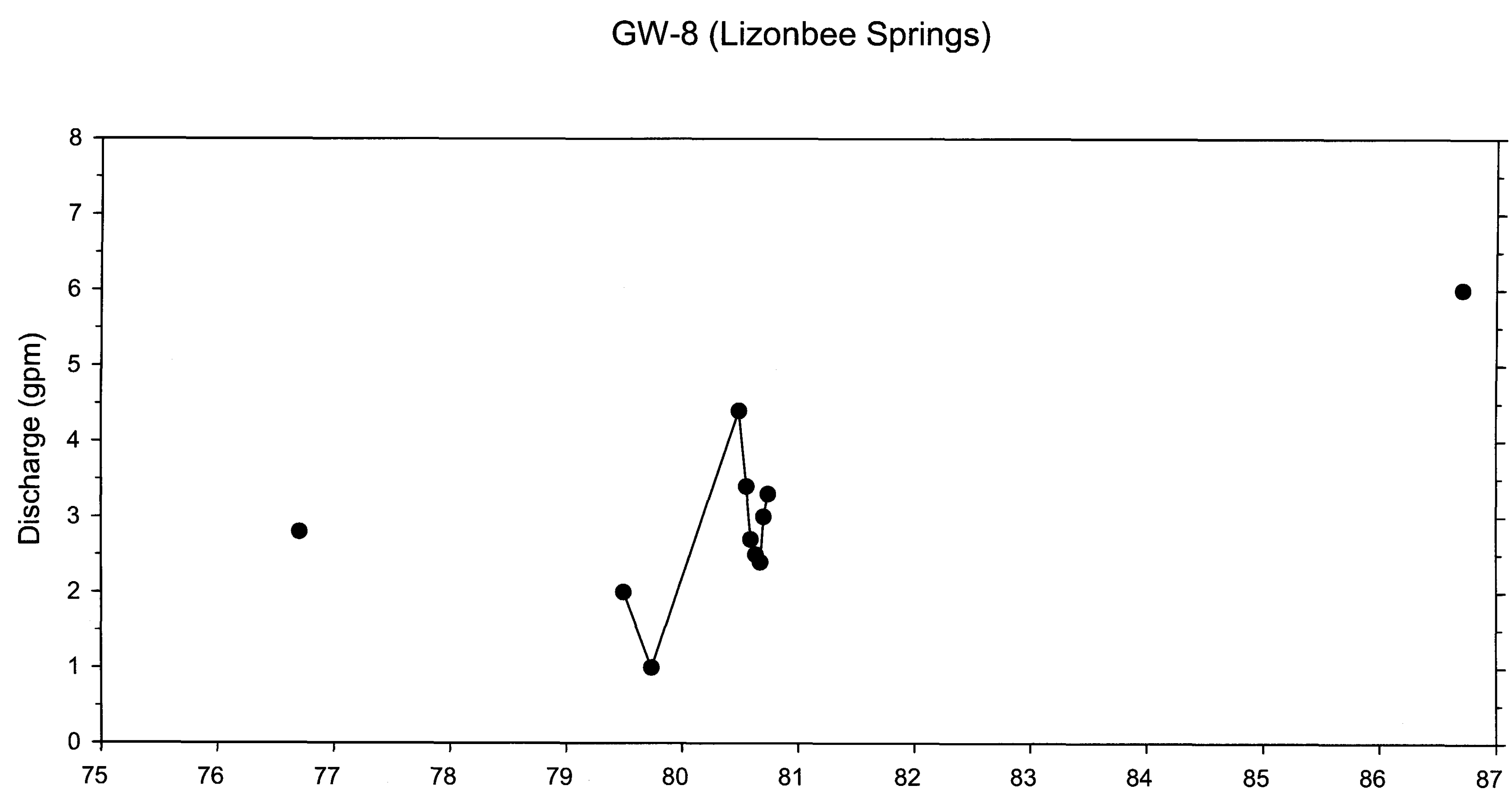


Figure 7d Discharge hydrograph for spring G-8 (Lizonbee Springs).

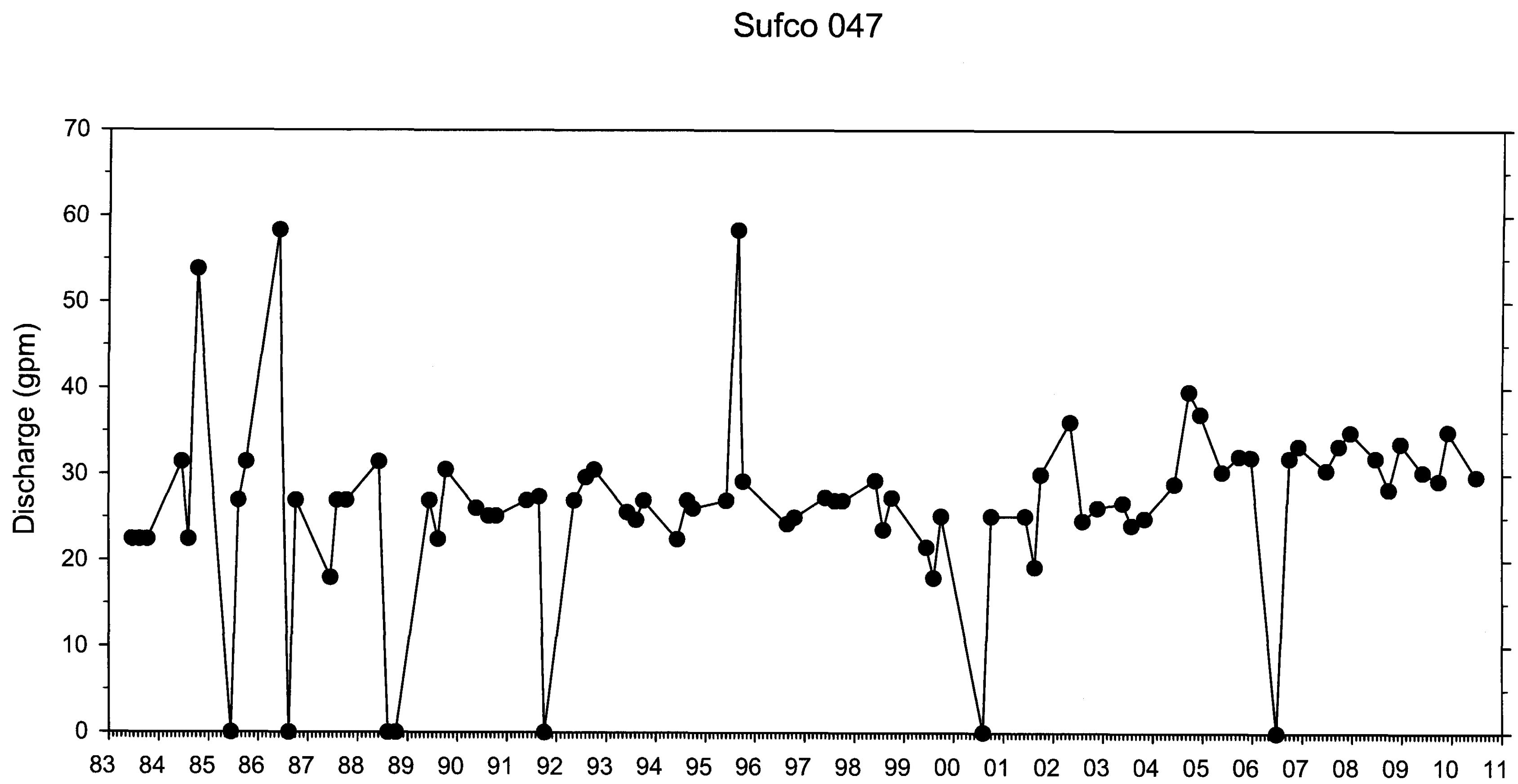


Figure 7e Discharge hydrograph for spring Sufco 047.

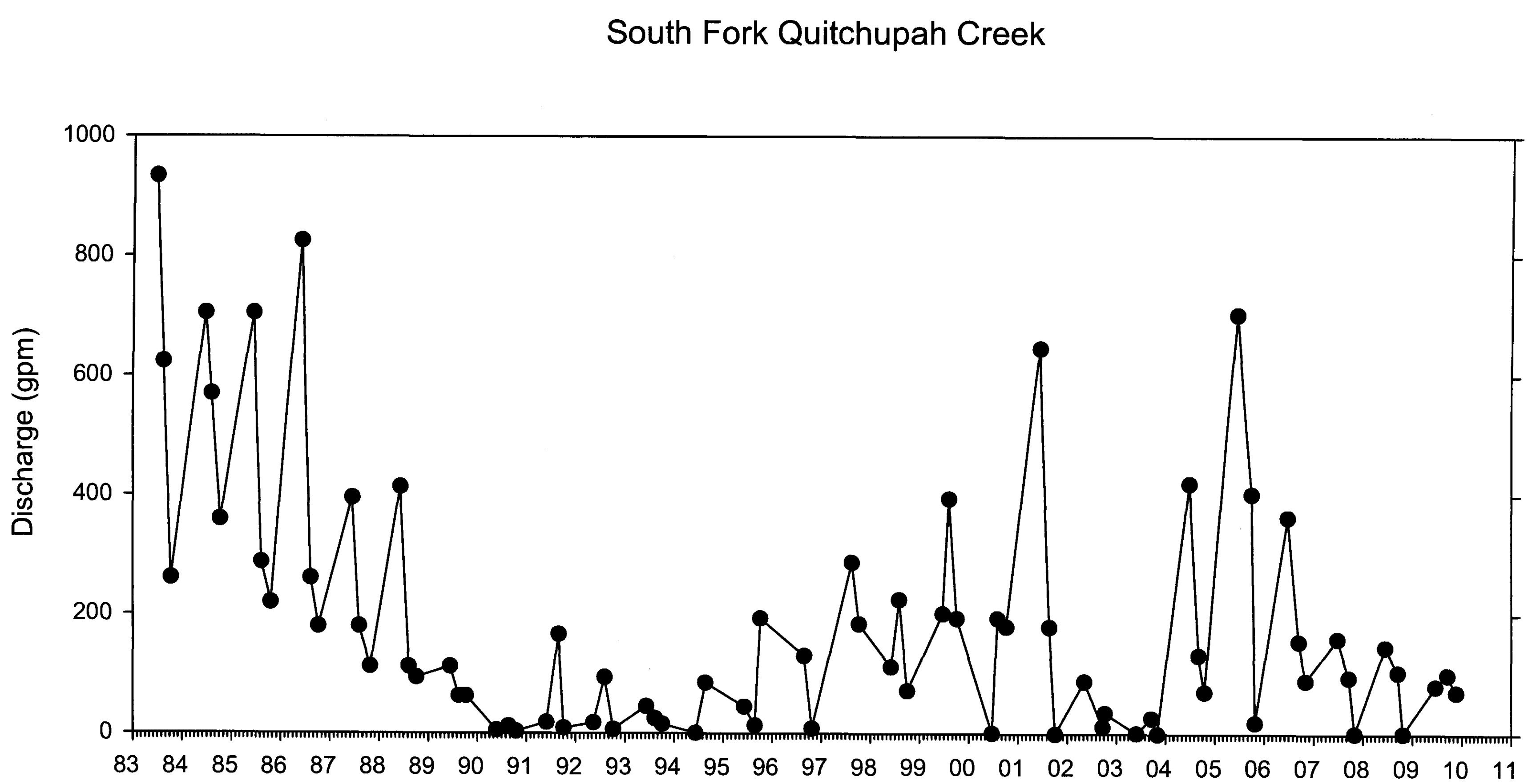


Figure 7f Discharge hydrograph for South Fork Quitchupah Creek (Sufco 006).

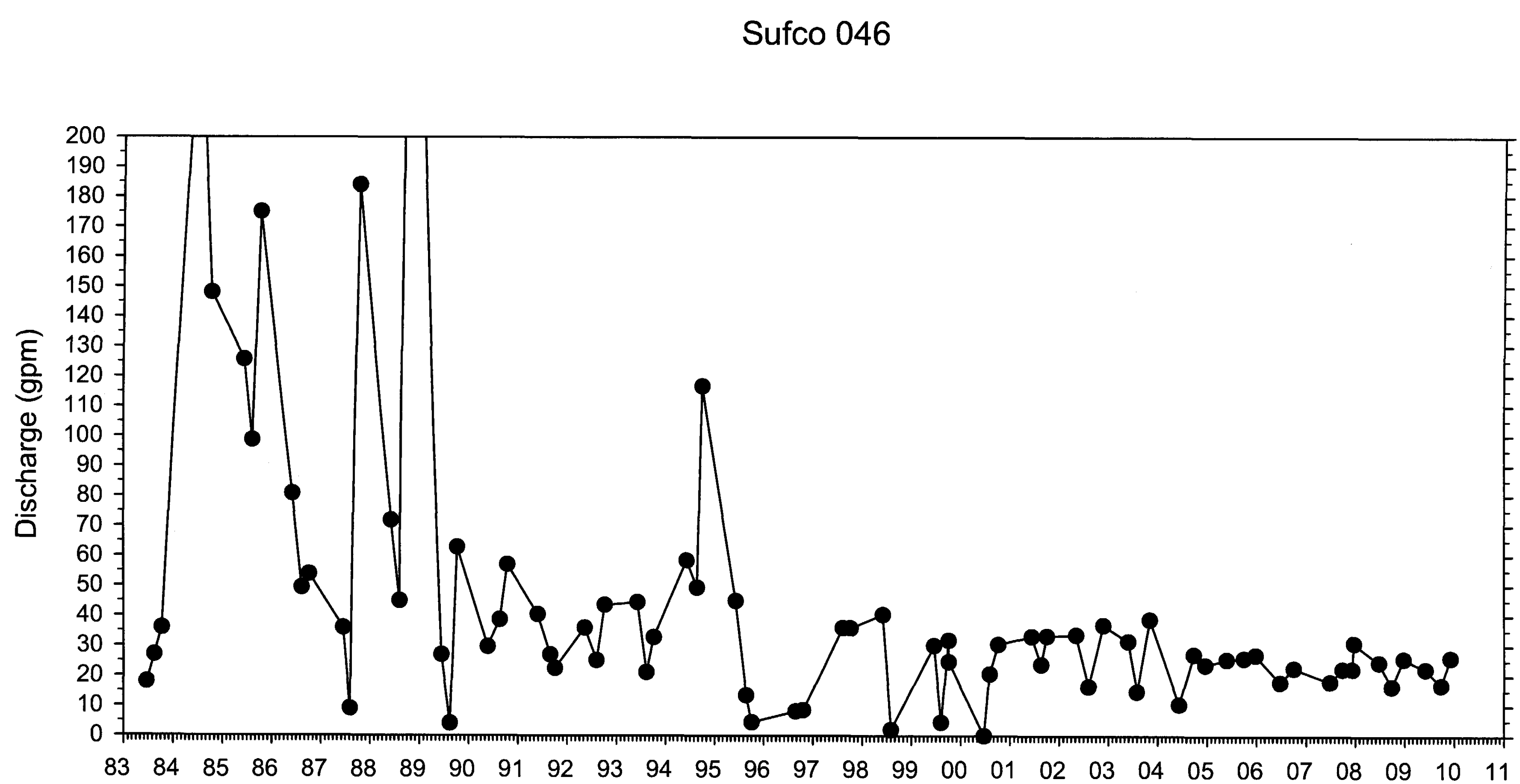


Figure 7g Discharge hydrograph for spring Sufco 046.

Sufco 047A

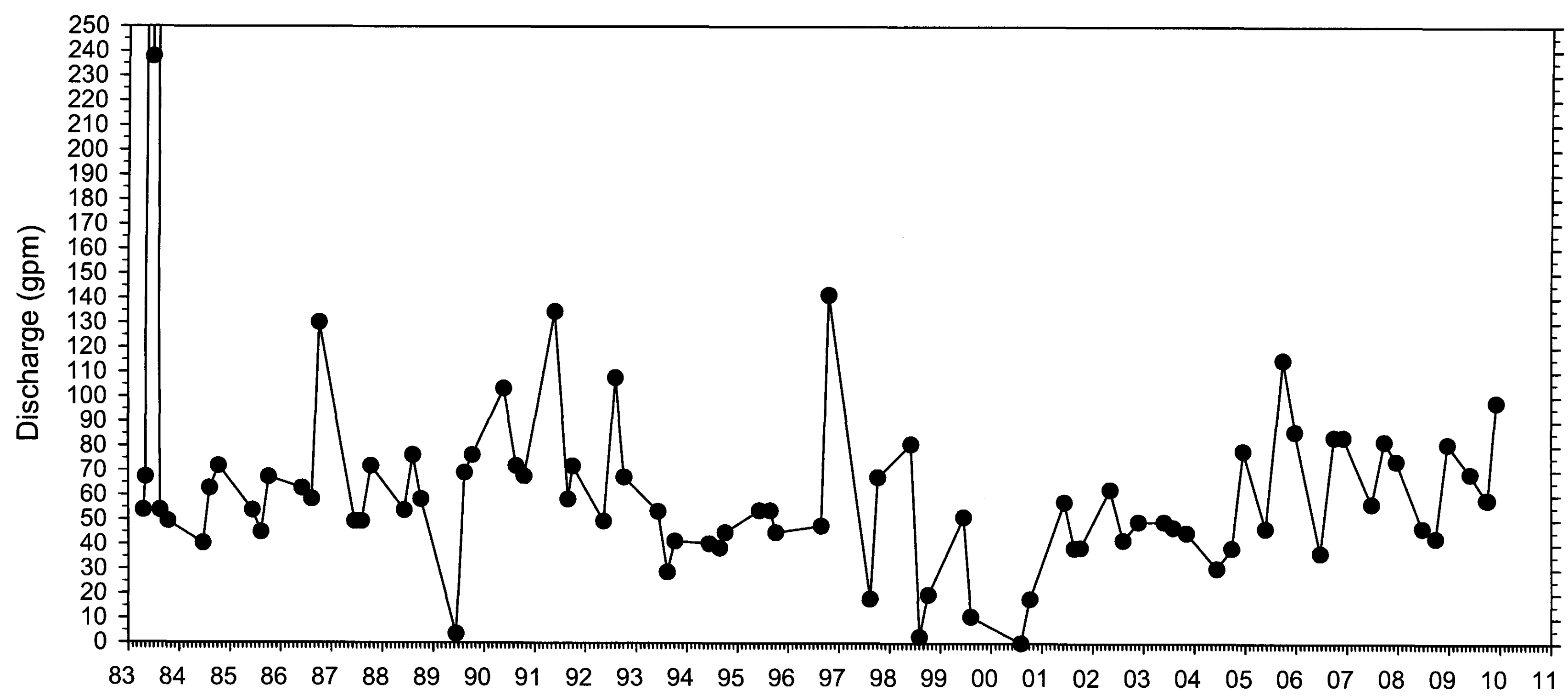


Figure 7h Discharge hydrograph for spring Sufco 047A.

US-80-2

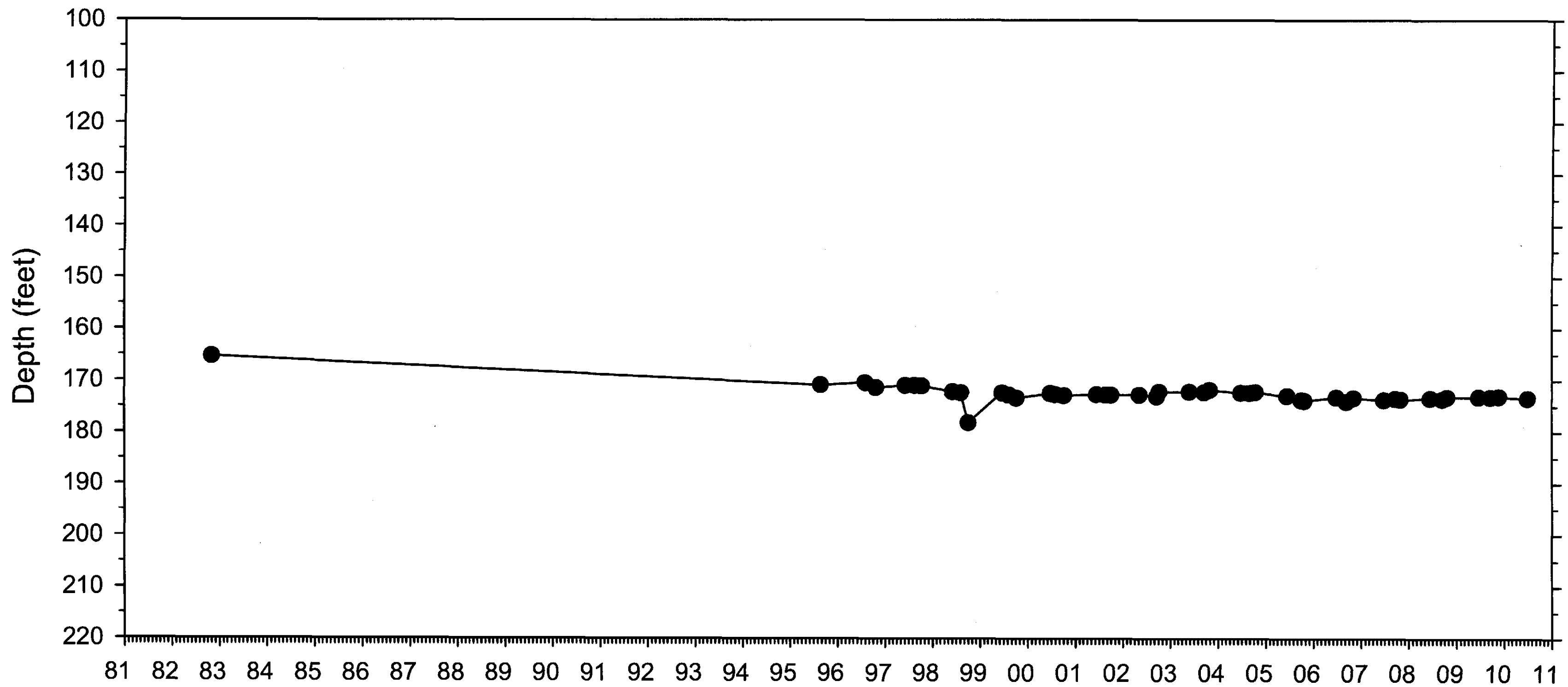


Figure 8a Water-level hydrograph for well US-80-2.

US-81-3

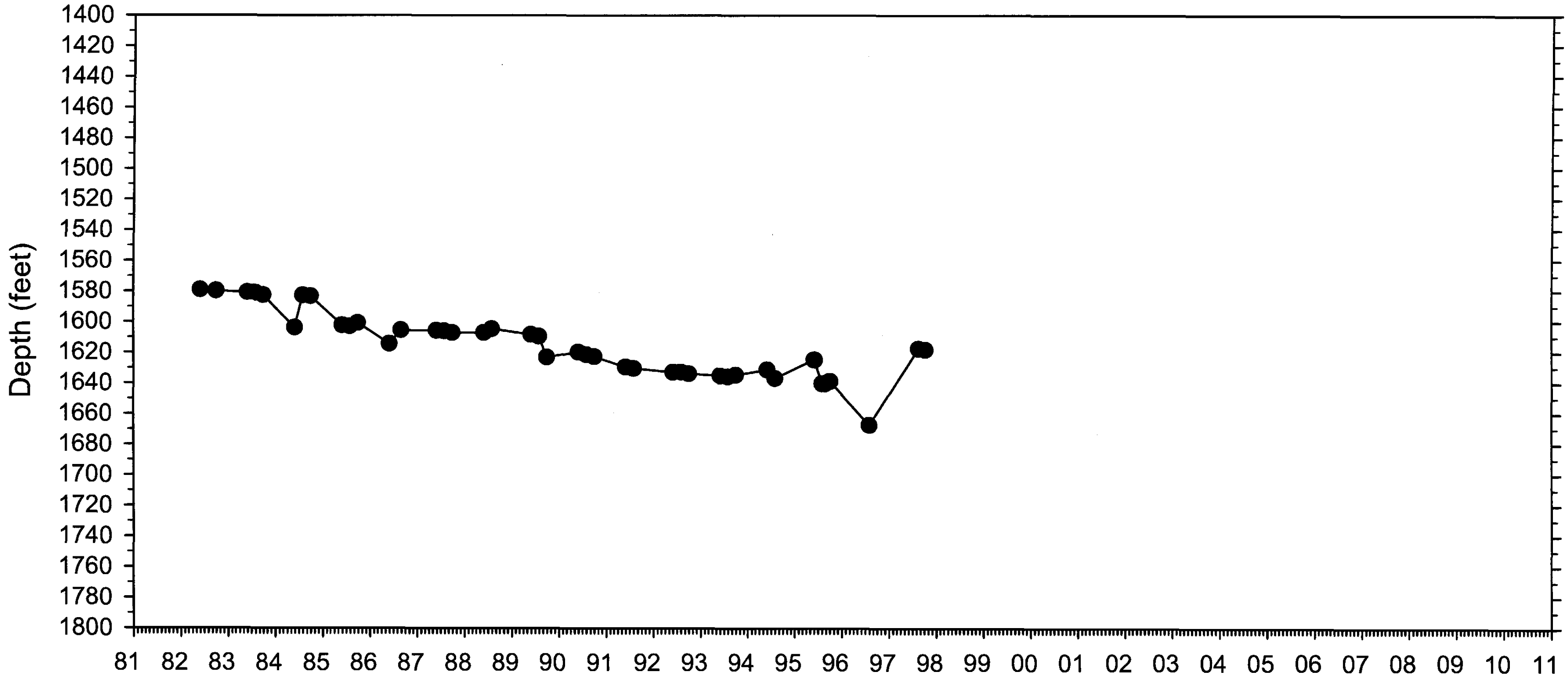


Figure 8b Water-level hydrograph for well US-81-3.

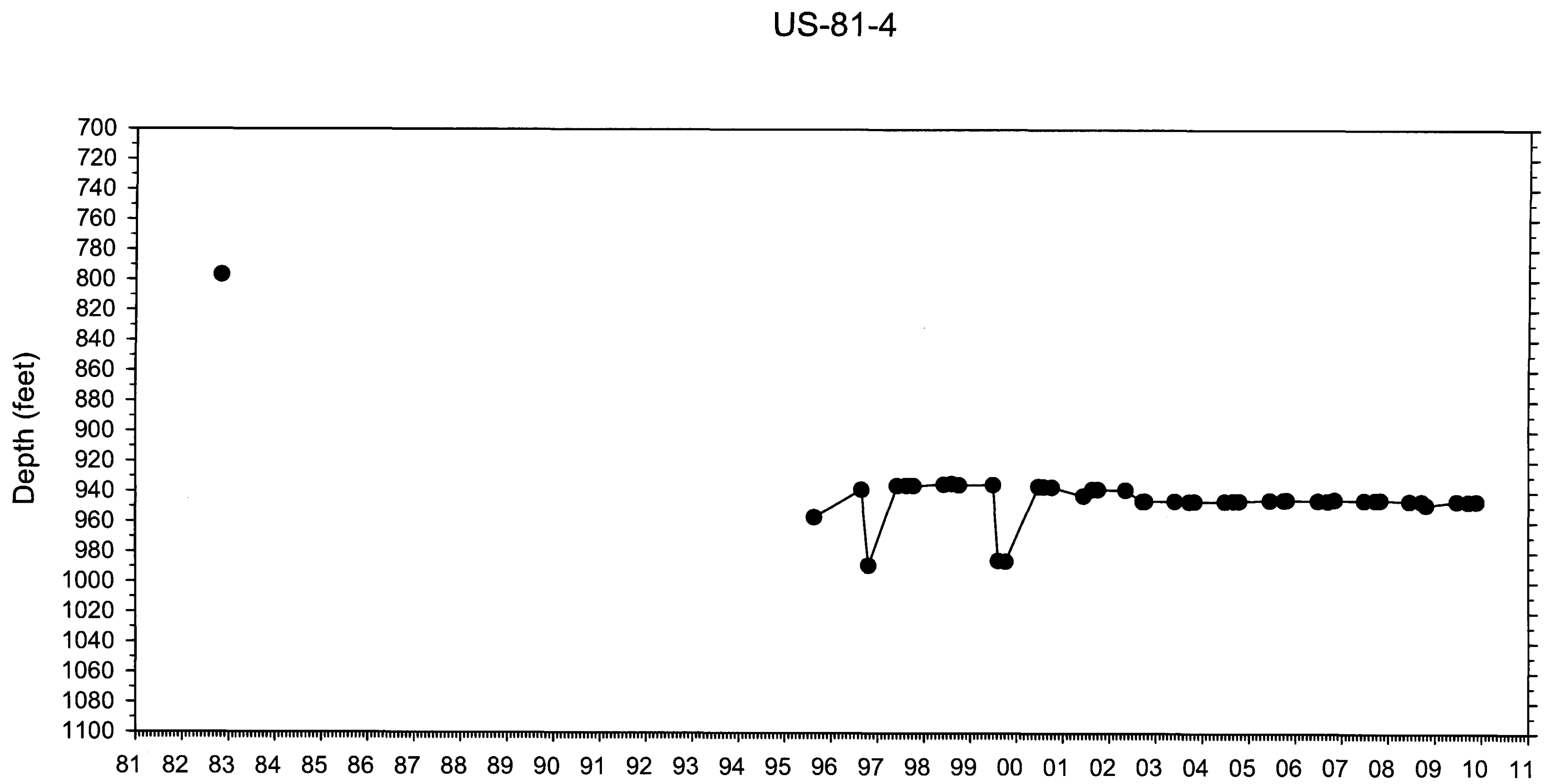


Figure 8c Water-level hydrograph for well US-81-4.

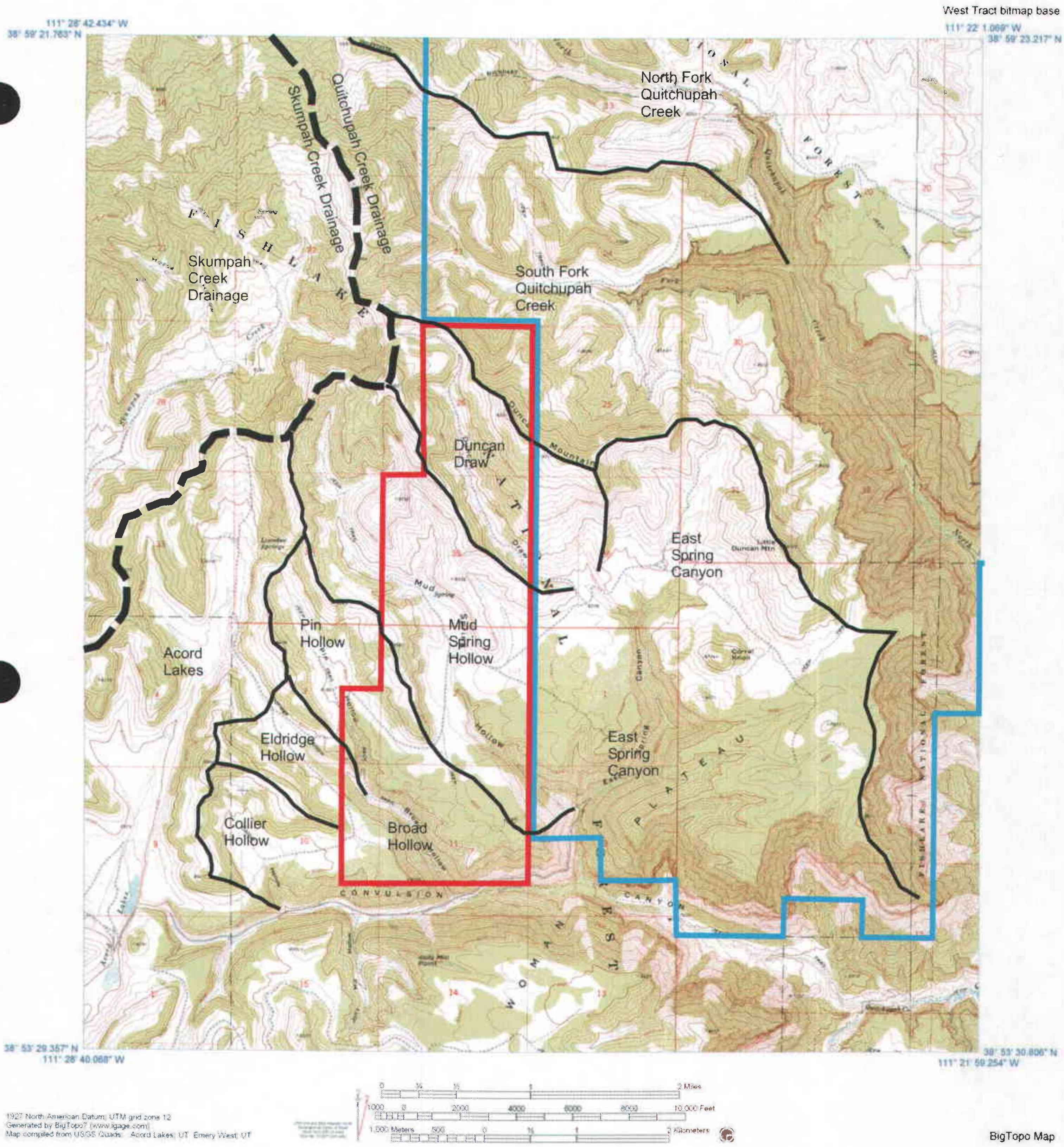


Figure 9 Surface-water drainages in the West Lease and surrounding area.

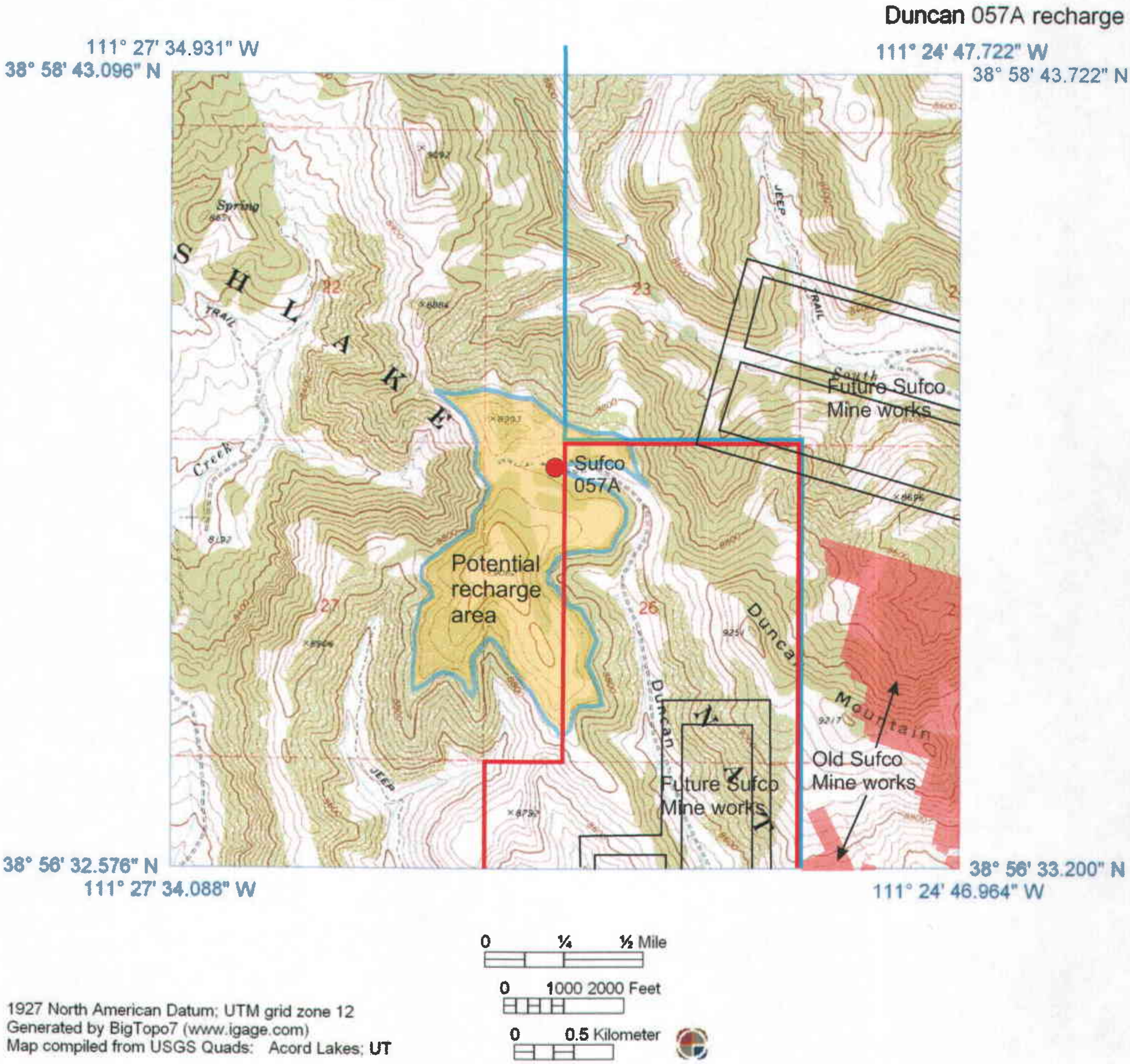


Figure 10 Potential recharge area for spring Sufco 057A.

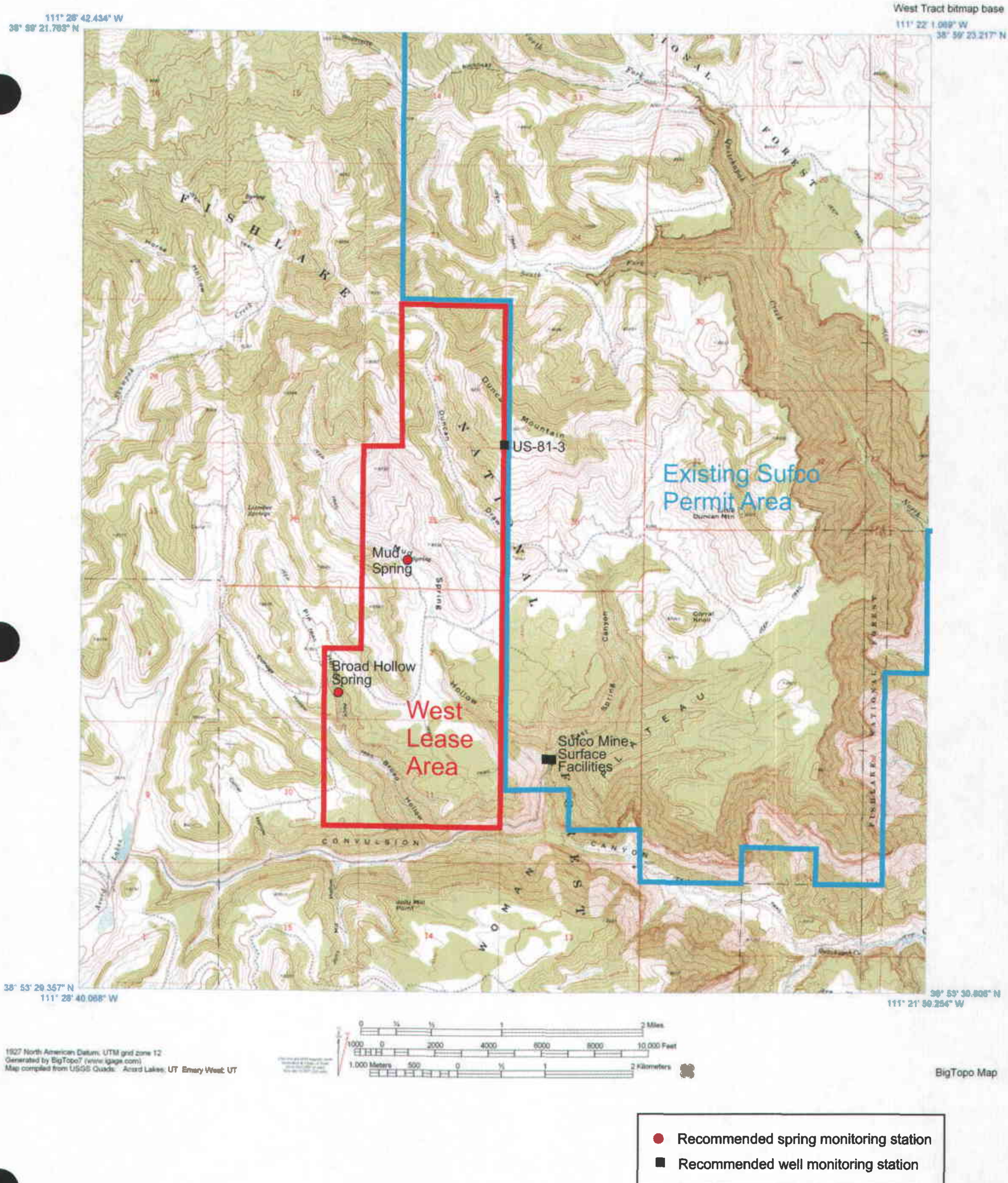


Figure 11 Recommended monitoring locations.

Table 1 Baseline monitoring site details.

	Geologic formation	Approximate location (UTM, Zone 12, NAD 27)		Use
Springs				
Sufco 057A	North Horn Formation	461907	4312329	Developed spring with stockwatering trough
Upper Mud Spring	Price River Formation (near North Horn Fm. contact)	461244	4311584	Developed spring with stockwatering trough
Middle Mud Spring	Price River Formation	461323	4310613	None apparent, stockwater pond in drainage below spring area
Mud Spring	Price River Formation	462273	4309551	Developed spring with stockwatering trough
Lower Mud Spring	Price River Formation	462488	4309401	None apparent, stockwater pond in drainage below spring area
Middle Duncan Spring	Price River Formation	462659	4310617	Developed Spring for stockwatering use
GW-8 (Lizonbee Springs)	Price River/Alluvium/Fault	460419	4310051	Stockwatering/Wildlife
GW-9 (Lizonbee Springs)	Price River/Alluvium/Fault	460381	4310082	Stockwatering/Wildlife
Broad Hollow Spring	Castlegate Sandstone	461537	4307942	Developed spring with stockwatering trough
Sufco 001 (East Spring)	Castlegate Sandstone	464524	4309303	Developed spring with stockwatering trough
Sufco 047 (source area)	Starpoint Sandstone	463800	4306464	Developed spring used for Sufco Mine water source

	Stream drainage	Approximate location (UTM, Zone 12, NAD 27)	
Streams			
Duncan Draw stream	Duncan Draw (Quitchupah Creek drainage)	463575	4309711
Mud Spring Hollow stream	Mud Spring Hollow (Quitchupah Creek drainage)	462580	4308935
Broad Hollow stream	Broad Hollow (Quitchupah Creek drainage)	461536	4307901
Sufco 006	South Fork Quitchupah Creek	463791	4312807
Sufco 046	Convulsion Canyon (Quitchupah Creek drainage)	463808	4306363
Sufco 047A	Quitchupah Creek tributary below Sufco Mine	464286	4306260

	Screened geologic formation	Approximate location (UTM, Zone 12, NAD 27)		Drilled well depth
Wells				
US-80-2	Castlegate Sandstone (base)	463400	4309472	207
US-81-3	Blackhawk Formation (Upper Hiawatha coal seam)	463400	4310841	1,980
US-81-4	Blackhawk Formation (Upper Hiawatha coal seam)	463645	4312322	1,300

Table 2 Discharge and water quality data for springs, wells, and streams in the West Lease Modification area.

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^{-} mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Springs and Wells																			
North Horn Formation																			
Sufco 057A	12-Aug-1987	Sufco/Petersen	0	21	667	7.6	408	97.03	16.46	9.15		348	0	11	19	0.32	0.01	0.12	10.11
Sufco 057A	28-Oct-1987	Sufco/Petersen	0.06	5	580	7.95	376	105.37	16.86	9.38		338	0	49	20.7	0.23	0.02	0.09	0.04
Sufco 057A	7-Jun-1988	Sufco/Petersen	0.90	15	613	7	328	107.2	4.8	9.79		329	0	7	15.2	0.16	0.03	0.05	0.03
Sufco 057A	9-Aug-1988	Sufco/Petersen	0																
Sufco 057A	13-Jun-1989	Sufco/Petersen	0																
Sufco 057A	15-Aug-1989	Sufco/Petersen	0																
Sufco 057A	9-Oct-1989	Sufco/Petersen	0																
Sufco 057A	23-May-1990	Sufco/Petersen	0																
Sufco 057A	21-Aug-1990	Sufco/Petersen	0																
Sufco 057A	16-Oct-1990	Sufco/Petersen	0																
Sufco 057A	29-May-1991	Sufco/Petersen	0																
Sufco 057A	27-Aug-1991	Sufco/Petersen	0																
Sufco 057A	4-Oct-1991	Sufco/Petersen	0																
Sufco 057A	12-May-1992	Sufco/Petersen	0																
Sufco 057A	4-Aug-1992	Sufco/Petersen	0																
Sufco 057A	7-Oct-1992	Sufco/Petersen	0																
Sufco 057A	7-Jun-1993	Sufco/Petersen	0.90	8.6			228	71.7	11	6.7		244	0	7.7	7.72	0	0	0	0
Sufco 057A	11-Aug-1993	Sufco/Petersen	0.09	17.8	699	7.1	334	108	17.6	10.2		361	0	6.4	17.9	0.06	0	0.025	0
Sufco 057A	4-Oct-1993	Sufco/Petersen	0																
Sufco 057A	6-Jun-1994	Sufco/Petersen	0																
Sufco 057A	23-Aug-1994	Sufco/Petersen	0																
Sufco 057A	6-Jun-1995	Sufco/Petersen	2.69	7.7	432	7.22	240	59	10	7	4	250		0	5		0		0
Sufco 057A	23-Aug-1995	Sufco/Petersen	0.27	17.8	617	7	350	96	16	11		355		3	14	0.7	0	0.1	0.1
Sufco 057A	3-Oct-1995	Sufco/Petersen	0.04	6	605	7.16	300	91	15	9	2	345	0	5	13	0.1	0.1	0	0
Sufco 057A	26-Aug-1996	Sufco/Petersen	0.00																
Sufco 057A	22-Oct-1996	Sufco/Petersen	0.00																
Sufco 057A	2-Jun-1997	Sufco/Petersen	1.16	16.4	572	7.40	310	82	13	7		322	0	7	11	<0.1	<0.1	<0.1	<0.1
Sufco 057A	18-Aug-1997	Sufco/Petersen	0.09	11.6	627	6.83	350	99	15	8		363	0	<5	14	<0.1	<0.1	<0.1	<0.1
Sufco 057A	24-Jun-1998	Sufco/Petersen	3.37	8.7	546	7.59													
Sufco 057A	3-Aug-1998	Sufco/Petersen	0.084	24.6	607	6.82													
Sufco 057A	1-Oct-1998	Sufco/Petersen	0.47	11.6	574	7.08													
Sufco 057A	17-Jun-1999	Sufco/Petersen	3.14	10.3	427	7.37													
Sufco 057A	10-Aug-1999	Sufco/Petersen	0.45	19.7	619	7.06													
Sufco 057A	11-Oct-1999	Sufco/Petersen	0.45	17.22	628	7.09													
Sufco 057A	22-Jun-2000	Sufco/Petersen	0.00																
Sufco 057A	2-Aug-2000	Sufco/Petersen	0.00																
Sufco 057A	6-Oct-2000	Sufco/Petersen	0.00																
Sufco 057A	11-Jun-2001	Sufco/Petersen	0.00																
Sufco 057A	20-Aug-2001	Sufco/Petersen	0.00																
Sufco 057A	2-Oct-2001	Sufco/Petersen	0.00																
Sufco 057A	8-May-2002	Sufco/Petersen	0.00																
Sufco 057A	20-Sep-2002	Sufco/Petersen	0.00																
Sufco 057A	8-Oct-2002	Sufco/Petersen	0.00																
Sufco 057A	29-May-2003	Sufco/Petersen	0.00																
Sufco 057A	19-Sep-2003	Sufco/Petersen	0.00																

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^{-} mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 057A	29-Oct-2003	Sufco/Petersen	0.00																
Sufco 057A	26-Jun-2004	Sufco/Petersen	0.00																
Sufco 057A	1-Sep-2004	Sufco/Petersen	0.00																
Sufco 057A	15-Oct-2004	Sufco/Petersen	0.00																
Sufco 057A	13-Jun-2005	Sufco/Petersen	1.52	16.6	431	7.56													
Sufco 057A	30-Sep-2005	Sufco/Petersen	0.004	18.2	706	7.55													
Sufco 057A	24-Oct-2005	Sufco/Petersen	0.018	11.3	544	7.65													
Sufco 057A	26-Jun-2006	Sufco/Petersen	0.60	18.1	586	6.37													
Sufco 057A	13-Sep-2006	Sufco/Petersen	0.00																
Sufco 057A	4-Nov-2006	Sufco/Petersen	0.031	6.5	482	7.66													
Sufco 057A	25-Jun-2007	Sufco/Petersen	0.00																
Sufco 057A	19-Sep-2007	Sufco/Petersen	0.00																
Sufco 057A	29-Oct-2007	Sufco/Petersen	0.00																
Sufco 057A	12-Jun-2008	Sufco/Petersen	0.00																
Sufco 057A	15-Sep-2008	Sufco/Petersen	0.00																
Sufco 057A	21-Oct-2008	Sufco/Petersen	0.00																
Sufco 057A	19-Jun-2009	Sufco/Petersen	0.00																
Sufco 057A	17-Sep-2009	Sufco/Petersen	0.00																
Sufco 057A	19-Nov-2009	Sufco/Petersen	0.00																
Sufco 057A	10-May-2010	Sufco/Petersen	0.00																
Sufco 057A	6-Aug-2010	Sufco/Petersen	0.00																
Average			**0.25**	**13.8**	**578**	**7.25**	**322**	**92**	**14**	**9**	**3**	**326**	**0**	**11**	**14**				
Price River Formation																			
Upper Mud Spring	27-Nov-2007	Sufco/Petersen	Dry																
Upper Mud Spring	2-Jul-2008	Sufco/Petersen	Dry																
Upper Mud Spring	10-May-2010	Sufco/Petersen	Dry																
Middle Mud Spring	27-Nov-2007	Sufco/Petersen	Dry																
Middle Mud Spring	2-Jul-2010	Sufco/Petersen	Dry																
Middle Mud Spring	10-May-2010	Sufco/Petersen	Dry																
Mud Spring	27-Nov-2007	Sufco/Petersen	Dry																
Mud Spring	2-Jul-2008	Sufco/Petersen	0 (no outflow)	12.2	1301	7.55													
Mud Spring	17-Sep-2009	Sufco/Petersen	Dry																
Mud Spring	23-Oct-2009	Sufco/Petersen	Dry																
Mud Spring	10-May-2010	Sufco/Petersen	0 (no outflow)	5.3	1032	7.92	799	165	35.97	32.95	3.76	273	0	323	43	3.68	<0.03	0.179	0.044
Mud Spring	16-Jul-2010	Sufco/Petersen	0 (no outflow)	16.7	1408	7.94													
Average			**0**	**11.4**	**1247**	**7.80**	**799**	**165**	**36**	**33**	**3.8**	**273**	**0**	**323**	**43**				
Lower Mud Spring	27-Nov-2007	Sufco/Petersen	Dry																
Lower Mud Spring	2-Jul-2008	Sufco/Petersen	<0.05	25.1	1158	7.74													
Lower Mud Spring	23-Oct-2009	Sufco/Petersen	Dry																
Lower Mud Spring	10-May-2010	Sufco/Petersen	Dry																
Middle Duncan Spring	12-Jun-2008	Sufco/Petersen	Dry																
Middle Duncan Spring	15-Sep-2008	Sufco/Petersen	Dry																
Middle Duncan Spring	21-Oct-2008	Sufco/Petersen	Dry																
Middle Duncan Spring	19-Jun-2009	Sufco/Petersen	Dry																
Middle Duncan Spring	17-Sep-2009	Sufco/Petersen	Dry																

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^{-} mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Middle Duncan Spring	19-Nov-2009	Sufco/Petersen	Dry																
Middle Duncan Spring	10-May-2010	Sufco/Petersen	Dry																
Middle Duncan Spring	6-Aug-2010	Sufco/Petersen	Dry																
GW-8 (Lizonbee Springs)	16-Sep-1976	USGS	2.8	10	1210	7.7	790	76	32	160	3.9	517	0	190	54		<0.01		
GW-8 (Lizonbee Springs)	1-Jul-1979	USGS	2.0	7	1100	7.5	650	79	29	110	3.3	317	0	190	71		0.02		
GW-8 (Lizonbee Springs)	27-Sep-1979	USGS	1.0	10	1220	7.7	770	84	33	160	4.2	488	0	180	52		0.03		
GW-8 (Lizonbee Springs)	30-Jun-1980	USGS	4.4	7.5	---														
GW-8 (Lizonbee Springs)	23-Jul-1980	USGS	3.4	7.5	1200														
GW-8 (Lizonbee Springs)	6-Aug-1980	USGS	2.7	8	1210														
GW-8 (Lizonbee Springs)	21-Aug-1980	USGS	2.5	8	1220														
GW-8 (Lizonbee Springs)	5-Sep-1980	USGS	2.4	7.5	1370														
GW-8 (Lizonbee Springs)	16-Sep-1980	USGS	3.0	8	1550														
GW-8 (Lizonbee Springs)	29-Sep-1980	USGS	3.3	8	1440														
GW-8 (Lizonbee Springs)	17-Sep-1986	USGS	6	7	1340	7.4	820	100	40	140	3.4	401	0	230	76		0.006		
GW-8 (Lizonbee Springs)	6-Aug-2010	Sufco/Petersen	2.7	6.9	1224	7.21													
Average			**3.02**	**8.0**	**1280**	**7.50**	**758**	**85**	**34**	**143**	**3.7**	**431**	**0**	**198**	**63.3**				
GW-9 (Lizonbee Springs)	5-Aug-1986	USGS	1.9	7.5	1170	7.7	689	98	35	110	3.6	373	0	170	61		0.004		
GW-9 (Lizonbee Springs)	17-Sep-1986	USGS	1.9	7.5	1220														
GW-9 (Lizonbee Springs)	6-Aug-2010	Sufco/Petersen	1.14	7.7	1288	7.44													
Average			**1.65**	**7.6**	**1226**	**7.57**	**689**	**98**	**35**	**110**	**3.6**	**373**	**0**	**170**	**61**				
Castlegate Sandstone																			
Broad Hollow Spring	16-Nov-2007	Sufco/Petersen	0.25 (est)																
Broad Hollow Spring	26-Nov-2007	Sufco/Petersen	frozen																
Broad Hollow Spring	12-Jun-2008	Sufco/Petersen	0.253	10.5	159	7.39													
Broad Hollow Spring	15-Sep-2008	Sufco/Petersen	0.013	15.1	243	6.86													
Broad Hollow Spring	21-Oct-2008	Sufco/Petersen	0.040	13.8	351	6.89													
Broad Hollow Spring	19-Jun-2009	Sufco/Petersen	0.013	29.2	238	6.15													
Broad Hollow Spring	17-Sep-2009	Sufco/Petersen	<0.1	19.8	277	6.61													
Broad Hollow Spring	23-Oct-2009	Sufco/Petersen	<0.1																
Broad Hollow Spring	19-Nov-2009	Sufco/Petersen	<0.1	2.5	246	6.88													
Broad Hollow Spring	10-May-2010	Sufco/Petersen	0.014	6.9	171	7.06	195	27.72	5.71	9.90	9.47	127	0	2	12	9.01	1.63	1.165	1.103
Broad Hollow Spring	16-Jul-2010	Sufco/Petersen	<0.1	17.7	232	6.86													
Average			**<0.25**	**14.4**	**240**	**6.84**	**195**	**28**	**6**	**9.9**	**9.5**	**127**	**0**	**2**	**12**				
Sufco 001 (East Spring)	15-Sep-1977	USGS Fig 17	1.6																
Sufco 001 (East Spring)	1-Jun-1978	USGS Fig 17	2.0																
Sufco 001 (East Spring)	25-Sep-1978	USGS Fig 17	2.5																
Sufco 001 (East Spring)	1-Jul-1979	USGS Fig 17	2.3																
Sufco 001 (East Spring)	5-Oct-1979	USGS Fig 17	2.1																
Sufco 001 (East Spring)	15-Jun-1980	USGS Fig 17	2.9																
Sufco 001 (East Spring)	1-Aug-1980	USGS Fig 17	3.0																
Sufco 001 (East Spring)	1-Aug-1980	USGS Fig 17	2.8																
Sufco 001 (East Spring)	5-Aug-1980	USGS	3.0	6	425														
Sufco 001 (East Spring)	20-Aug-1980	USGS Fig 17	2.6																
Sufco 001 (East Spring)	21-Aug-1980	USGS	2.7	6.5	435														
Sufco 001 (East Spring)	5-Sep-1980	USGS Fig 17	2.2																
Sufco 001 (East Spring)	5-Sep-1980	USGS	2.90	6.5	440														

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^{-} mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 001 (East Spring)	15-Sep-1980	USGS Fig 17	2.4																
Sufco 001 (East Spring)	16-Sep-1980	USGS	3.00	6	425														
Sufco 001 (East Spring)	29-Sep-1980	USGS	2.70	6.5	435														
Sufco 001 (East Spring)	27-Oct-1980	USGS Fig 17	2.7																
Sufco 001 (East Spring)	1-Jun-1981	USGS Fig 17	1.9																
Sufco 001 (East Spring)	1-Oct-1981	USGS Fig 17	3.0																
Sufco 001 (East Spring)	20-May-1982	USGS Fig 17	3.2																
Sufco 001 (East Spring)	15-Aug-1982	USGS Fig 17	2.8																
Sufco 001 (East Spring)	20-Oct-1982	USGS Fig 17	2.7																
Sufco 001 (East Spring)	20-Jun-1983	USGS Fig 17	4.1																
Sufco 001 (East Spring)	21-Jun-1983	Sufco/Petersen	4.17	6	420	7.3	238	50.4	21.12	12		227	0	28	28	0.01	0.01	0.003	0.002
Sufco 001 (East Spring)	14-Aug-1983	USGS Fig 17	4.4																
Sufco 001 (East Spring)	16-Aug-1983	Sufco/Petersen	4.62	14	430	7.1	260	49.6	23.04	11.5		249	0	32	22	0.01	0.01	0.002	0.001
Sufco 001 (East Spring)	12-Oct-1983	Sufco/Petersen	3.90	9	340	7.1	220	48	18.24	9	0.3	203	0	28	14	0.01	0.009	0.015	0.01
Sufco 001 (East Spring)	21-Jun-1984	Sufco/Petersen	5.08	7	390	7.2	250	64.4	10.8	14	0.5	232	0	25	18.4	0.04	0.01	0.02	0.01
Sufco 001 (East Spring)	9-Aug-1984	Sufco/Petersen	5.17	7	450	7.25	290	60	19.2	40		256	0	26	18.2	0.16	0.01	0.01	0.01
Sufco 001 (East Spring)	11-Oct-1984	Sufco/Petersen	7.32	6	360	7.35	286	46	32.4	10.7		205	0	27	16	0.2	0.02	0.01	0.01
Sufco 001 (East Spring)	13-Jun-1985	Sufco/Petersen	5.77	6	921	6.8	596	49.6	64.3	80	5.1	312	0	202	60.4	1.13	0.01	0.03	0.01
Sufco 001 (East Spring)	14-Aug-1985	Sufco/Petersen	5.17	6	432	7.5	280	51.2	18.5	45	4.9	220	0	27	21.6	0.06	0.01	0.02	0.01
Sufco 001 (East Spring)	22-Oct-1985	Sufco/Petersen	4.35	6	455	7.45	266	60	13.2	10.7		268	0	20	19.9	0.28	0.2	0.02	0.01
Sufco 001 (East Spring)	4-Jun-1986	Sufco/Petersen	4.17	5.5	461	7.55	242	49.6	23	11.81		235	0	29	23	0.02	0.01	0.01	0.01
Sufco 001 (East Spring)	13-Aug-1986	Sufco/Petersen	3.66	6	438	7.5	220	57.6	17.3	13.51		232	0	22	20.1	0.11	0.01	0.01	0.01
Sufco 001 (East Spring)	22-Aug-1986	USGS	4.40	6.5	470	6.9	296	56	20	12	1.4	230	0	22	22		0.006		
Sufco 001 (East Spring)	18-Sep-1986	USGS	4.00	7	460														
Sufco 001 (East Spring)	25-Sep-1986	USGS Fig 17	3.7																
Sufco 001 (East Spring)	9-Oct-1986	Sufco/Petersen	4.49	6	467	8	268	52.8	20.2	9.2		185.4	0	23	1	0.04	0.01	0.01	0.01
Sufco 001 (East Spring)	10-Oct-1986	USGS	---	7	450														
Sufco 001 (East Spring)	10-Oct-1986	USGS Fig 17	2.2																
Sufco 001 (East Spring)	20-Oct-1986	USGS Fig 17	3.3																
Sufco 001 (East Spring)	15-Dec-1986	USGS	3.1	6.5	440														
Sufco 001 (East Spring)	12-May-1987	USGS	4.3	6	450														
Sufco 001 (East Spring)	16-Jun-1987	USGS	3.8	6	500														
Sufco 001 (East Spring)	18-Jun-1987	Sufco/Petersen	4.49	6	489	7.6	270	72	9.6	12.76		233	0	25	23	0.02	0.01	0.01	0.01
Sufco 001 (East Spring)	20-Jul-1987	USGS	3.4	6.5	480														
Sufco 001 (East Spring)	5-Aug-1987	Sufco/Petersen	4.49	6.5	570	7.8	302	51.9	19.38	13.52		217	0	25	26.1	0.03	0.01	0.01	0.01
Sufco 001 (East Spring)	9-Sep-1987	USGS	3.2	7	480														
Sufco 001 (East Spring)	28-Oct-1987	Sufco/Petersen	4.49	5	450	7.9	280	59.6	21.93	14.29		236	0	42	25.4	0.1	0.01	0.01	0.01
Sufco 001 (East Spring)	7-Jun-1988	Sufco/Petersen	2.69	5.5	556	7	286	76	12	14.48		232	0	21	25.8	0.07	0.03	0.01	0.01
Sufco 001 (East Spring)	9-Aug-1988	Sufco/Petersen	2.24	6	513	7.4	328	96	0.96	15.08		229	0	22	2	0.03	0.03	0.01	0.01
Sufco 001 (East Spring)	5-Oct-1988	Sufco/Petersen	2.51	6	560	6.6	390	108	16.8	13.66		287	0	112	10	0.03	0.03	0.01	0.01
Sufco 001 (East Spring)	14-Jun-1989	Sufco/Petersen	2.33	6.5	593	6.8	518	59.25	22.95	15.48		250	0	23	32.5	0.03	0.03	0.01	0.01
Sufco 001 (East Spring)	15-Aug-1989	Sufco/Petersen	2.24	8.5	597	6.2	294	55.11	22.72	16.66		233	0	23	32.4	0.03	0.03	0.01	0.01
Sufco 001 (East Spring)	9-Oct-1989	Sufco/Petersen	2.15	6.5	613	7.1	266	59.58	22.29	16.21		240	0	22	32.7	0.03	0.03	0.05	0.01
Sufco 001 (East Spring)	23-May-1990	Sufco/Petersen	2.06	5	488	7.1	310	61.21	23.2	17.54		244	0	25	36	0.08	0.03	0.01	0.01
Sufco 001 (East Spring)	21-Aug-1990	Sufco/Petersen	1.71	7.5	584	7.8	260	55.59	22.65	18.44		237	0	23.3	36	0.03	0.03	0.01	0.01
Sufco 001 (East Spring)	15-Oct-1990	Sufco/Petersen	1.39	7.5	575	7.2	334	51.35	19.13	19.03		248	0	23.4	36.3	0.12	0.03	0.01	0.02
Sufco 001 (East Spring)	29-May-1991	Sufco/Petersen	1.53	5	539	7.53	318	57.41	22.98	18.46		240	0	30	35	0.05	0.05	0.03	0.03
Sufco 001 (East Spring)	27-Aug-1991	Sufco/Petersen	1.44	5.5	567	7.17	290	64.21	26.52	19.5		253	0	23.7	36.3	0.05	0.05	0.03	0.03
Sufco 001 (East Spring)	3-Oct-1991	Sufco/Petersen	1.35	6	550	7.14	302	56.82	23.58	17.64		250	0	24.2	37	0	0	0	0
Sufco 001 (East Spring)	12-May-1992	Sufco/Petersen	1.30	6	429	7.4	312	63	24.46	17.46		247	0	19.3	31.5	0.08	0.02	0	0

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^- mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^- mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 001 (East Spring)	4-Aug-1992	Sufco/Petersen	1.17	7	574	6.97	340	42.5	19.5	16.7	1.46	195	0	25	37	0.16	0.08	0	0
Sufco 001 (East Spring)	6-Oct-1992	Sufco/Petersen	1.17	6.5	628	7.64	310	58.5	22.9	16.5		198	0	26	55.9	0.06	0.05	0	0
Sufco 001 (East Spring)	9-Jun-1993	Sufco/Petersen	1.21	6.5	591	7.54	316	67.2	25.4	21.1		231	0	22.6	36.1	0.01	0.04	0	0
Sufco 001 (East Spring)	12-Aug-1993	Sufco/Petersen	1.12	6.5	615	7.17	304	63.8	25	19.9		231	0	23.8	37.6	0.04	0.04	0	0
Sufco 001 (East Spring)	5-Oct-1993	Sufco/Petersen	1.03	7	573	7.12	306	61.3	24	20.2		223	0	23	36.8	0.11	0.04	0	0
Sufco 001 (East Spring)	8-Jun-1994	Sufco/Petersen	0.63	6.5	560	7.4	354	53.8	19.5	17.8		252	0	23	39	0.034	0.03	0	0
Sufco 001 (East Spring)	23-Aug-1994	Sufco/Petersen	0.27	8	559	7.14	292	67	26	22		204	0	27	39	0.02	0.02	0.01	0.01
Sufco 001 (East Spring)	7-Jun-1995	Sufco/Petersen	0.63	10	588	7.07	360	61	25			250	0	23	37	0	0.2	0	0
Sufco 001 (East Spring)	25-Aug-1995	Sufco/Petersen	0.18	8	584	7.52		55	22	19		250	0	23	38	0	0	0	0
Sufco 001 (East Spring)	3-Oct-1995	Sufco/Petersen	0.90	14	590	7.32	290	58	24	19	2	245	0	22	37	0	0	0	0
Sufco 001 (East Spring)	27-Aug-1996	Sufco/Petersen	0.45	11.3	583	7.11	245	60	23	18		245	0	25	38	<0.1	<0.1	<0.1	<0.1
Sufco 001 (East Spring)	2-Jun-1997	Sufco/Petersen	0.73	13	609	7.34	320	59	25	21		252	0	22	37	2.8	0.2	<0.1	<0.1
Sufco 001 (East Spring)	18-Aug-1997	Sufco/Petersen	3.59	16.02	590	7.07	320	63	22	18		250	0	<5	5	<0.1	<0.1	<0.1	<0.1
Sufco 001 (East Spring)	8-Oct-1997	Sufco/Petersen	1.35	6.1	594	7.52	320	58	22	18		244	0	21	36	0.5	0.2	<0.1	<0.1
Sufco 001 (East Spring)	4-Jun-1998	Sufco/Petersen	0.83	8.2	568	7.67													
Sufco 001 (East Spring)	3-Aug-1998	Sufco/Petersen	0.45	18.85	581	7.23													
Sufco 001 (East Spring)	1-Oct-1998	Sufco/Petersen	0.81	9.16	566	7.15													
Sufco 001 (East Spring)	30-Jun-1999	Sufco/Petersen	0.90	18.3	583	7.23													
Sufco 001 (East Spring)	10-Aug-1999	Sufco/Petersen	0.45	11.09	697	7.39													
Sufco 001 (East Spring)	4-Oct-1999	Sufco/Petersen	0.90	13.81	587	7.34													
Sufco 001 (East Spring)	22-Jun-2000	Sufco/Petersen	0.45	5	580	7.34													
Sufco 001 (East Spring)	1-Aug-2000	Sufco/Petersen	0.90	10	595	7.32													
Sufco 001 (East Spring)	6-Oct-2000	Sufco/Petersen	0.76	2	592	7.24													
Sufco 001 (East Spring)	11-Jun-2001	Sufco/Petersen	0.37	7	568	7.27													
Sufco 001 (East Spring)	20-Aug-2001	Sufco/Petersen	0.89	17.2	576	6.98													
Sufco 001 (East Spring)	2-Oct-2001	Sufco/Petersen	0.35	7.2	582	7.33													
Sufco 001 (East Spring)	8-May-2002	Sufco/Petersen	0.52	4	584	7.26													
Sufco 001 (East Spring)	20-Sep-2002	Sufco/Petersen	0.68	8.1	568	7.43													
Sufco 001 (East Spring)	8-Oct-2002	Sufco/Petersen	0.72	6.2	567	7.24													
Sufco 001 (East Spring)	29-May-2003	Sufco/Petersen	1.00	8.2	495	8.02													
Sufco 001 (East Spring)	19-Sep-2003	Sufco/Petersen	0.73	6.2	486	7.46													
Sufco 001 (East Spring)	29-Oct-2003	Sufco/Petersen	0.70	8.1	498	7.66													
Sufco 001 (East Spring)	26-Jun-2004	Sufco/Petersen	0.63	14.1	508	7.57													
Sufco 001 (East Spring)	1-Sep-2004	Sufco/Petersen	0.45	12.3	521	7.54													
Sufco 001 (East Spring)	15-Oct-2004	Sufco/Petersen	0.62	7.1	498	7.98													
Sufco 001 (East Spring)	13-Jun-2005	Sufco/Petersen	0.66	16.6	486	7.43													
Sufco 001 (East Spring)	30-Sep-2005	Sufco/Petersen	0.56	16.3	511	7.45													
Sufco 001 (East Spring)	24-Oct-2005	Sufco/Petersen	0.45	6.9	468	7.71													
Sufco 001 (East Spring)	26-Jun-2006	Sufco/Petersen	0.48	6.9	512	7.77													
Sufco 001 (East Spring)	13-Sep-2006	Sufco/Petersen	0.60	22.9	458	7.24													
Sufco 001 (East Spring)	4-Nov-2006	Sufco/Petersen	0.82	5	433	7.88													
Sufco 001 (East Spring)	25-Jun-2007	Sufco/Petersen	0.72	22.3	495	7.44													
Sufco 001 (East Spring)	19-Sep-2007	Sufco/Petersen	0.55	20.5	491	7.56													
Sufco 001 (East Spring)	29-Oct-2007	Sufco/Petersen	0.72	87.8	457	8.25													
Sufco 001 (East Spring)	12-Jun-2008	Sufco/Petersen	0.30	18.1	509	7.76													
Sufco 001 (East Spring)	15-Sep-2008	Sufco/Petersen	0.44	24.7	502	7.38													
Sufco 001 (East Spring)	21-Oct-2008	Sufco/Petersen	0.16	8.8	470	7.41													
Sufco 001 (East Spring)	19-Jun-2009	Sufco/Petersen	0.42	17.2	514	7.27													
Sufco 001 (East Spring)	17-Sep-2009	Sufco/Petersen	0.31	20.6	515	7.88													
Sufco 001 (East Spring)	19-Nov-2009	Sufco/Petersen	0.72	4.7	635	7.33													

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^- mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^- mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 001 (East Spring)	10-May-2010	Sufco/Petersen	0.52	4.2	497	7.28													
Average			**2.07**	**9.8**	**523**	**7.37**	**306**	**60**	**22**	**19**	**2**	**237**	**0**	**31**	**29**				
US-80-2 (Castlegate Sandstone well)	27-Oct-1981	Sufco/Petersen			450	7.4	290	56	17.76	34.2		258.9	0	3	10.2		0.122		
Star Point Sandstone																			
Sufco 047	22-Jun-1983	Sufco/Petersen	22.4	25	740	7.4	490	80	46.56	22		422.1	0	92	22	0.01	0.01	0.015	0.015
Sufco 047	16-Aug-1983	Sufco/Petersen	22.4	28	740	7.6	480	80.8	38.4	21		412.4	0	144	20	0.03	0.03	0.03	0.02
Sufco 047	12-Oct-1983	Sufco/Petersen	22.4	27	650	7.3	440	81.6	40.8	14	2.5	378.2	0	76	14	0.11	0.098	0.03	0.04
Sufco 047	20-Jun-1984	Sufco/Petersen	31.4	27	700	7.25	460	120.4	22.32	22.2	3.1	419.7	0	71	15.1	0.07	0.01	0.03	0.01
Sufco 047	9-Aug-1984	Sufco/Petersen	22.4	28	840	7.3	545	84	51.6	76		463.6	0	47	14.9	0.15	0.02	0.04	
Sufco 047	11-Oct-1984	Sufco/Petersen	53.9	25	700	7.2	560	94	45.6	68		463.6	0	90	16	0.11	0.01	0.06	0.06
Sufco 047	13-Jun-1985	Sufco/Petersen	0.0	27	350	7.4	224	53.6	17.8	25	3.5	218	0	22	20.5	0.02	0.01	0.01	0.01
Sufco 047	14-Aug-1985	Sufco/Petersen	26.9	29	830	7.2	530	87.2	37.9	120	4	392.8	0	82	17.8	0.04	0.01	0.06	0.05
Sufco 047	9-Oct-1985	Sufco/Petersen	31.4	27	778	6.65	524	107.4	27.98	16		394	0	69	20	0.12	0.01	0.07	0.05
Sufco 047	4-Jun-1986	Sufco/Petersen	58.3	28	779	7.4	466	91.2	38.4	21.57		414	0	78	17.9	0.46	0.01	0.11	0.1
Sufco 047	13-Aug-1986	Sufco/Petersen	0.0		751	7.5	430	88.8	39.4	21.19		390.4	0	177	26.6	0.09	0.01	0.11	0.02
Sufco 047	9-Oct-1986	Sufco/Petersen	26.9	28.5	760	8	462	91.2	36.5	18.4		364.5	0	86	17.1	0.04	0.01	0.08	0.05
Sufco 047	16-Jun-1987	Sufco/Petersen	18.0	28	792	7.6	456	114.4	23	19.74		387	0	79	15.4	0.06	0.01	0.08	0.09
Sufco 047	5-Aug-1987	Sufco/Petersen	26.9	29	853	7.6	504	80.5	38.53	20.42		364	0	74	15.4	0.04	0.01	0.09	0.09
Sufco 047	13-Oct-1987	Sufco/Petersen	26.9	30	750	7.8	400	84.71	37.69	32		369	0	87	18.8	0.2	0.01	0.08	0.06
Sufco 047	8-Jun-1988	Sufco/Petersen	31.4	29	865	7.8	480	146.4	10	21.23		411	0	78	15.3	0.1	0.03	0.08	0.08
Sufco 047	9-Aug-1988	Sufco/Petersen	0.0		817	6.2	540	163.2	0.08	22.46		387	0	83	49.9	0.03	0.03	0.08	0.08
Sufco 047	5-Oct-1988	Sufco/Petersen	0.0		819	6.2	612	144	43.2	20.45		410	0	195	18	0.03	0.03	0.06	0.05
Sufco 047	13-Jun-1989	Sufco/Petersen	26.9	29.5	873	6.2	492	88.79	42.87	21.12		341	0	*1	17	0.03	0.03	0.07	0.06
Sufco 047	14-Aug-1989	Sufco/Petersen	22.4	29.1	854	6.1	488	82.83	44.27	21.86		397	0	83	16.1	0.03	0.03	0.07	0.05
Sufco 047	10-Oct-1989	Sufco/Petersen	30.5	28	856	7.1	888	85.99	41.87	21.82		405	0	79	16	0.03	0.03	0.02	0.01
Sufco 047	22-May-1990	Sufco/Petersen	26.0	27.8	702	6.7	418	89.83	44.12	22.31		400	0	86	17.2	0.03	0.03	0.05	0.05
Sufco 047	21-Aug-1990	Sufco/Petersen	25.1	28.9	818	7.3	434	84.16	43.04	21.71		379	0	81	17	0.03	0.03	0.06	
Sufco 047	16-Oct-1990	Sufco/Petersen	25.1	25.6	833	7	498	44.63	21.41	12.01		404	0	75.5	15.3	0.11	0.03	0.07	0.05
Sufco 047	28-May-1991	Sufco/Petersen	26.9	26	590	6.9	482	75.62	45.04	23.53		398	0	75.5	17	0.5	0.5	0.04	0.04
Sufco 047	28-Aug-1991	Sufco/Petersen	27.4	26.7	779	7.15	468	94.57	49.14	22.85		414	0	82	16.5	0	0	0.05	0.04
Sufco 047	3-Oct-1991	Sufco/Petersen	0.0		785	7.18	474	59.17	43.07	21.52		408	0	84.5	3.7	0.02	0.02	0.04	0.03
Sufco 047	13-May-1992	Sufco/Petersen	26.9	28	590	7.5	464	93.8	46.82	19.68		413	0	66.5	16	0.04	0.02	0.05	0.05
Sufco 047	6-Aug-1992	Sufco/Petersen	29.6	17	808	6.79	460	60.2	34.4	19	2.87	324	0	83	18.2	0.11	0.15	0.05	0.05
Sufco 047	7-Oct-1992	Sufco/Petersen	30.5	29.5	773	7.28	450	69.1	41.1	19.5		319	0	81	27.9	0.15	0.06	0.04	0.05
Sufco 047	8-Jun-1993	Sufco/Petersen	25.6	29	848	7.15	476	94.3	47	24.9		408	0	81.2	16.2	0.04	0.04	0.023	0.031
Sufco 047	12-Aug-1993	Sufco/Petersen	24.7	29.2	835	6.94	446	95.3	48.2	23.7		392	0	76.4	15.8	0.04	0.04	0.045	0.03
Sufco 047	5-Oct-1993	Sufco/Petersen	26.9	29.5	799	6.78	466	88.9	43.7	20.6		310	0	89.9	15.5	0.02	0.04	0.028	0.03
Sufco 047	8-Jun-1994	Sufco/Petersen	22.4	25.8	779	7.05	584	80.6	35.7	20.7		407	0	87	18	0.035	0.07	0.04	0.034
Sufco 047	22-Aug-1994	Sufco/Petersen	26.9	27.5	817	6.94	470	90	43	24		334	0	93	16	0.02	0.02	0.06	0.06
Sufco 047	3-Oct-1994	Sufco/Petersen	26.0	25.7	808	6.96	450	92	45	24		340	0	68	18	0.04	0.02	0.06	0.05
Sufco 047	5-Jun-1995	Sufco/Petersen	26.9	24.8	840	6.76	510	82	40			420	0	70	17	0	0	0	0
Sufco 047	25-Aug-1995	Sufco/Petersen	58.3	30	814	7.09	460	81	41	23		400	0	77	17	0	0	0	0
Sufco 047	4-Oct-1995	Sufco/Petersen	29.2	24.6	823	6.98	420	83	41	21		400	0	43	17	0	0	0	0
Sufco 047	27-Aug-1996	Sufco/Petersen	24.2	27	814	7.23	472					382	5	67	18	< .1	< .1	< .1	41
Sufco 047	21-Oct-1996	Sufco/Petersen	25.0	23.4	831	7.08	477					412	< 5.	90	19	< .1	< .1	< .1	41
Sufco 047	2-Jun-1997	Sufco/Petersen	27.3	22.92	833	6.96	490					407	< 5.	86	18	< .1	< .1	< .1	42
Sufco 047	11-Aug-1997	Sufco/Petersen	26.9	27.5	821	6.98	480					403	< 5.	85	18	< .1	< .1	< .1	40
Sufco 047	8-Oct-1997	Sufco/Petersen	26.9	24	817	7.2	480					416	< 5.	168	18	< .1	< .1	< .1	40
Sufco 047	4-Jun-1998	Sufco/Petersen	29.3	22.5	845	7.46	483	86	41	20	3	440	< 5.	56	18	< .1	< .1	< .1	
Sufco 047	3-Aug-1998	Sufco/Petersen	23.6	25.26	822	6.93	492	85	41	20	3	412	< 5.	84	20	< .1	< .1	< .1	
Sufco 047	4-Oct-1998	Sufco/Petersen	27.3	23.15	773	6.94	520	85	44	22	5	418	< 5.	80	17	0.1	< .1	< .1	

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^- mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^- mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 047	17-Jun-1999	Sufco/Petersen	21.5	26.33	837	6.84	466	84	40	22	3	410	< 5.	87	17	< .1	< .1	< .1	
Sufco 047	9-Aug-1999	Sufco/Petersen	18.0	27.02	832	6.93													
Sufco 047	4-Oct-1999	Sufco/Petersen	25.1	26.65	836	7	468	85	40	21	3	413	< 5.	86	17	< .1	< .1	< .1	
Sufco 047	21-Jun-2000	Sufco/Petersen		25.61	839	6.93	495	84	40	21	3	404	< 5.	88	< 1.	< .1	< .1	< .1	
Sufco 047	2-Aug-2000	Sufco/Petersen	0.1	26.9	845	7.15	484	87	41	21	3	403	< 5.	86	17	< .1	< .1	< .1	
Sufco 047	5-Oct-2000	Sufco/Petersen	25.1	27	857	6.87	460	84	42	21	3	400	< 5.	84	17	< .1	< .1	< .1	
Sufco 047	11-Jun-2001	Sufco/Petersen	25.1	28.5	877	6.81	467	87	41	22	3	405	< 5.	100	18	< .1	< .1	< .1	
Sufco 047	20-Aug-2001	Sufco/Petersen	19.2	30.1	784	7.08	502	85	41	21	3	403	< 5.	87	17.3	< .1	< .01	< .05	
Sufco 047	2-Oct-2001	Sufco/Petersen	30.0	27.5	807	7.71	481	87	42	23	4	408	< 5.	90	18.7	< .1	< .1	< .05	
Sufco 047	7-May-2002	Sufco/Petersen	36.1	28.2	789	7.45	459	89	41	23	3	411	< 5.	86	17	< .1	< .1	0.07	
Sufco 047	6-Aug-2002	Sufco/Petersen	24.6	29.7	781	7.66	462	85	41	23	3	378	< 5.	85	16	< .1	< .1	0.1	
Sufco 047	25-Nov-2002	Sufco/Petersen	26.1	27.9	690	7.91	448	80	38	20	3	403	< 5.	86	15	< .1	< .1	0.07	
Sufco 047	28-May-2003	Sufco/Petersen	26.7	28.4	813	7.67	472	85.9	42.2	21.3	3.27	399	< 5.	87	17	0.024	< .005	0.061	
Sufco 047	1-Aug-2003	Sufco/Petersen	24.1	30.2	791	7.42	450	86.3	40.8	20.4	3.3	367	< 5.	86	17	0.031	< .005	0.068	
Sufco 047	5-Nov-2003	Sufco/Petersen	24.9	29.4	823	7.54	448	88.3	42.7	20.6	3.26	403	< 5.	91	16	< .02	< .005	0.083	
Sufco 047	8-Jun-2004	Sufco/Petersen	28.9	28.6	842	7.51	476	89.1	41.2	20.9	3.18	328	< 5.	88	17	< .05	< .03	0.131	
Sufco 047	24-Sep-2004	Sufco/Petersen	39.6	30.1	820	7.62	445	96.3	45.4	21.2	3.29	330	< 5.	92	15	< .05	< .03	0.092	
Sufco 047	17-Dec-2004	Sufco/Petersen	37.0	27.2	753	7.39	454	90.9	43.6	22.5	3.2	338	< 5.	97	17	< .05	< .03	0.05	
Sufco 047	24-May-2005	Sufco/Petersen	30.3	28.3	834	7.19	487	87.3	41.6	21	3.2	399	< 5.	90	28	< .05	< .03	0.062	
Sufco 047	28-Sep-2005	Sufco/Petersen	32.1	29.2	902	7.66	454	92.2	43	22.6	3.37	405	< 5.	94	22	< .05	< .03	0.091	
Sufco 047	22-Dec-2005	Sufco/Petersen	32.0	27.2	788	7.66	359	91	43.1	22.3	3.53	397	< 5.	84	16	< .05	< .03	0.05	
Sufco 047	26-Jun-2006	Sufco/Petersen	0.0	24.8	866	7.36	495	91.1	43.8	22.1	3.27	398	< 5.	85	19	< .05	< .03	0.003	
Sufco 047	30-Sep-2006	Sufco/Petersen	31.9	29.5	734	7.27	480	87.47	41.63	21.88	3.29	401	< 5.	82	16	< .05	< .03	0.13	
Sufco 047	6-Dec-2006	Sufco/Petersen	33.3	27.1	747	7.2	450	90.95	44.32	21.7	3.29	398	< 5.	85	17	< .05	< .03	0.098	
Sufco 047	25-Jun-2007	Sufco/Petersen	30.5	29.4	783	7.37	473	90.2	42.9	21.5	2.98	376	< 5.	81	17	< .05	< .03	0.068	
Sufco 047	26-Sep-2007	Sufco/Petersen	33.3	29.7	831	7.72	467	91.1	42.9	22.6	3.39	399	< 5.	83	18	< .05	< .03	0.079	
Sufco 047	21-Dec-2007	Sufco/Petersen	34.9	27.7	674	7.69	522	86.04	41.86	21.16	3.39	408.44	< 5.	83	17	< .05	< .03	0.072	
Sufco 047	23-Jun-2008	Sufco/Petersen	31.9	29.1	805	7.44	473	90.14	43.55	21.72	3.22	382.83	< 5.	83	17	< .05	< .03	0.085	
Sufco 047	25-Sep-2008	Sufco/Petersen	28.3	29.8	782	7.66	485	91.96	46.78	21.58	3.3	469.4	< 5.	84	17	< .05	< .03	0.076	
Sufco 047	22-Dec-2008	Sufco/Petersen	33.6	28	784	7.72	500	89.85	42.97	22.58	3.41	377.96	< 5.	86	18	< .05	< .03	0.065	
Sufco 047	1-Jun-2009	Sufco/Petersen	30.3	28.7	779	7.39	479	92.18	44.6	21.94	3.38	387.71	< 5.	85	17	< .05	< .03	0.088	
Sufco 047	24-Sep-2009	Sufco/Petersen	29.3	30.1	782	7.53	484	89.87	44.5	21.79	3.48	407.22	< 5.	83	17	0.06	< .03	0.072	
Sufco 047	3-Dec-2009	Sufco/Petersen	35.0	27.8	754	7.38	479	87.23	43.14	23.23	3.47	398.68	< 5.	85	18	< .05	< .03	0.082	
Sufco 047	28-Jun-2010	Sufco/Petersen	29.8																
Average			**26.3**	**27.4**	**789**	**7.22**	**479**	**89**	**40**	**24**	**3**	**392**	**<5**	**86**	**18**				

Streams

Duncan Draw stream	25-Jun-2007	Sufco/Petersen	0
Duncan Draw stream	19-Sep-2007	Sufco/Petersen	0
Duncan Draw stream	29-Oct-2007	Sufco/Petersen	0
Duncan Draw stream	12-Jun-2008	Sufco/Petersen	0
Duncan Draw stream	15-Sep-2008	Sufco/Petersen	0
Duncan Draw stream	21-Oct-2008	Sufco/Petersen	0
Duncan Draw stream	19-Jun-2009	Sufco/Petersen	0
Duncan Draw stream	17-Sep-2009	Sufco/Petersen	0
Duncan Draw stream	19-Nov-2009	Sufco/Petersen	0
Duncan Draw stream	10-May-2010	Sufco/Petersen	0
Duncan Draw stream	6-Aug-2010	Sufco/Petersen	0

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^- mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^- mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Mud Spring Hollow stream	27-Nov-2007	Sufco/Petersen	0																
Mud Spring Hollow stream	2-Jul-2008	Sufco/Petersen	0																
Mud Spring Hollow stream	17-Sep-2009	Sufco/Petersen	0																
Mud Spring Hollow stream	23-Oct-2009	Sufco/Petersen	0																
Mud Spring Hollow stream	10-May-2010	Sufco/Petersen	0																
Mud Spring Hollow stream	16-Jul-2010	Sufco/Petersen	0																
Broad Hollow stream	16-Nov-2007	Sufco/Petersen	0																
Broad Hollow stream	26-Nov-2007	Sufco/Petersen	0																
Broad Hollow stream	12-Jun-2008	Sufco/Petersen	0																
Broad Hollow stream	15-Sep-2008	Sufco/Petersen	0																
Broad Hollow stream	21-Oct-2008	Sufco/Petersen	0																
Broad Hollow stream	19-Jun-2009	Sufco/Petersen	0																
Broad Hollow stream	17-Sep-2009	Sufco/Petersen	0																
Broad Hollow stream	23-Oct-2009	Sufco/Petersen	0																
Broad Hollow stream	19-Nov-2009	Sufco/Petersen	0																
Broad Hollow stream	10-May-2010	Sufco/Petersen	0																
Broad Hollow stream	16-Jul-2010	Sufco/Petersen	0																
Sufco 006 (South Fork Quitchupah Creek)	21-Jun-1983	Sufco/Petersen	934	16	710	8	424	60	35.52	59		400.2	0	74	36	0.81	0.03	0.065	0.042
Sufco 006 (South Fork Quitchupah Creek)	16-Aug-1983	Sufco/Petersen	624	17	680	7.6	432	56	33.6	52.5		370.9	0	62	4	5.4	0.09	0.045	0.015
Sufco 006 (South Fork Quitchupah Creek)	12-Oct-1983	Sufco/Petersen	260	10	750	7.8	490	68	37.92	55	3.5	390.4	0	87	34	0.25	0.04	0.08	0.07
Sufco 006 (South Fork Quitchupah Creek)	21-Jun-1984	Sufco/Petersen	705	11	760	7.7	490	91.6	18.72	66	3.6	416	0	66	36.4	0.07	0.01	0.04	0.03
Sufco 006 (South Fork Quitchupah Creek)	9-Aug-1984	Sufco/Petersen	570	18	1300	7.8	850	64	108	47.8		384.3	0	405	29.4	1.3	0.07	0.09	
Sufco 006 (South Fork Quitchupah Creek)	11-Oct-1984	Sufco/Petersen	359	6	680	8.1	520	64	55.5	60.3		390.4	0	95	34	0.06	0.23	0.09	0.07
Sufco 006 (South Fork Quitchupah Creek)	13-Jun-1985	Sufco/Petersen	705	14	490	8	316	58.8	23.8	40	3.8	256	0	75	14.2	24.6	0.03	0.73	0.01
Sufco 006 (South Fork Quitchupah Creek)	14-Aug-1985	Sufco/Petersen	287	13	708	8.4	460	60	32.2	80	3.5	348.9	0	85	28	0.06	0.01	0.03	0.02
Sufco 006 (South Fork Quitchupah Creek)	22-Oct-1985	Sufco/Petersen	220	1	719	8.2	484	77.6	36.5	49.8		329.4	0	87	24.5	0.56	0.01	0.09	0.05
Sufco 006 (South Fork Quitchupah Creek)	3-Jun-1986	Sufco/Petersen	826	16	635	8.35	366	50.4	33.1	38.03		279	0	95	20.3	0.62	0.01	0.07	0.02
Sufco 006 (South Fork Quitchupah Creek)	13-Aug-1986	Sufco/Petersen	260	17	622	8.4	340	54.4	34.6	39.82		275.7	14.4	69	17.2	0.57	0.01	0.05	0.01
Sufco 006 (South Fork Quitchupah Creek)	9-Oct-1986	Sufco/Petersen	180	6	742	8.2	446	64.8	33.6	55.2		256.2	0	80	3.9	1.01	0.02	0.11	0.06
Sufco 006 (South Fork Quitchupah Creek)	18-Jun-1987	Sufco/Petersen	395	10	666	8	406	84	18.7	34.72		315	0	77	15	0.26	0.01	0.07	0.05
Sufco 006 (South Fork Quitchupah Creek)	5-Aug-1987	Sufco/Petersen	180	18	717	8.2	438	54.8	31.29	34.12		301	0	75	13.7	0.2	0.01	0.08	0.05
Sufco 006 (South Fork Quitchupah Creek)	28-Oct-1987	Sufco/Petersen	112	5	635	8.2	418	62.63	33.53	43.53		348	0	80	17.4	0.64	0.01	0.11	0.09
Sufco 006 (South Fork Quitchupah Creek)	7-Jun-1988	Sufco/Petersen	413	16	715	7.9	388	114.4	0.1	29.69		316	0	73	11.3	0.3	0.03	0.09	0.05
Sufco 006 (South Fork Quitchupah Creek)	9-Aug-1988	Sufco/Petersen	112	17.5	659	8.25	430	115.2	2.88	32.59		301	0	83	32.5	0.68	0.03	0.09	0.03
Sufco 006 (South Fork Quitchupah Creek)	5-Oct-1988	Sufco/Petersen	94	15.5	782	7.1	577	156	8.4	38.81		381	0	174	15	0.75	0.03	0.15	0.08
Sufco 006 (South Fork Quitchupah Creek)	14-Jun-1989	Sufco/Petersen	112	15.5	798	7.3	468	65.48	32.61	40.05		344	0	18	2.9	0.86	0.2	0.17	0.14
Sufco 006 (South Fork Quitchupah Creek)	15-Aug-1989	Sufco/Petersen	63	19.5	759	7.1	470	63.57	27.35	43.68		328	0	84	13.8	1.29	0.03	0.08	0.01
Sufco 006 (South Fork Quitchupah Creek)	9-Oct-1989	Sufco/Petersen	63	14	857	7.9	426	63.88	33.32	44.46		374	0	87	2.9	0.67	0.03	0.13	0.08
Sufco 006 (South Fork Quitchupah Creek)	23-May-1990	Sufco/Petersen	5	17.4	814	7.6	492	69.76	38.54	66.47		407	0	98	34	0.24	0.03	0.01	0.01
Sufco 006 (South Fork Quitchupah Creek)	20-Aug-1990	Sufco/Petersen	12	17.3	973	8.4	628	75.96	43.98	57.21		392	0	102	23.3	0.03	0.03	0.02	
Sufco 006 (South Fork Quitchupah Creek)	15-Oct-1990	Sufco/Petersen	3	12.1	964	7.8	598	42.4	23.72	43.46		468	0	93.5	24.8	0.27	0.03	0.06	0.04
Sufco 006 (South Fork Quitchupah Creek)	29-May-1991	Sufco/Petersen	18	21.3	912	8.01	564	50.43	43.29	73.15		382	0	115	32.5	0.211	0.505	0.09	0.03
Sufco 006 (South Fork Quitchupah Creek)	27-Aug-1991	Sufco/Petersen	166	14.8	434	8.07	422	67.56	33.31	34.62		285	0	100	8.3	0.48	0.05	0.05	0.04
Sufco 006 (South Fork Quitchupah Creek)	3-Oct-1991	Sufco/Petersen	9	15.2	893	7.8	538	41.08	44.75	66.96		431	0	100	37	0.06	0	0.03	0.03
Sufco 006 (South Fork Quitchupah Creek)	12-May-1992	Sufco/Petersen	18	15.5	686	8.1	544	63.03	48.09	64.77		399	0	93	26	1.33	0	0.09	0
Sufco 006 (South Fork Quitchupah Creek)	4-Aug-1992	Sufco/Petersen	94	17.9	735	7.84	452	52.1	30.1	36.6	2.97	262	0	100	11.3	1	0.13	0.04	0.01
Sufco 006 (South Fork Quitchupah Creek)	6-Oct-1992	Sufco/Petersen	7	10.7	1044	8.08	580	80.4	47.4	68.7		358	0	126	35.2	0.08	0.05	0.02	0.02

Site	Date	Data Source*	Flow	Water T	Cond	pH	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{2-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(D)	Mn(T)	Mn(D)
			gpm	°C	µS/cm	SU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sufco 006 (South Fork Quitchupah Creek)	9-Jun-1993	Sufco/Petersen	45	18.4	1032	8.22	602	71.8	41.8	88.2		468	0	101	33.1	0	0	0.05	0.029
Sufco 006 (South Fork Quitchupah Creek)	11-Aug-1993	Sufco/Petersen	25	19.7	641	8.36	344	62.3	36.7	24.7		247	6.9	78.9	6.88	0	0	0.023	0.02
Sufco 006 (South Fork Quitchupah Creek)	4-Oct-1993	Sufco/Petersen	16	15.4	943	7.95	568	67.4	45	66.7		372	0	112	21.3	0.018	0	0.018	0
Sufco 006 (South Fork Quitchupah Creek)	8-Jun-1994	Sufco/Petersen	0	20.8	865	8.44	586	46.7	34.7	71.5		380	0	114	35	0.285	0.03	0.019	0
Sufco 006 (South Fork Quitchupah Creek)	23-Aug-1994	Sufco/Petersen	85	20.2	775	8.18	442	77	40	48		278	0	93	13	1.54	0.02	0.06	0.03
Sufco 006 (South Fork Quitchupah Creek)	6-Jun-1995	Sufco/Petersen	45	16.1	977	8.07	570	73	35	78	4	420	0	95	33		0.1		0
Sufco 006 (South Fork Quitchupah Creek)	24-Aug-1995	Sufco/Petersen	13	16	578	8.46	320	56	32	18		235	20	73	6	0.3	0	0	0
Sufco 006 (South Fork Quitchupah Creek)	3-Oct-1995	Sufco/Petersen	193	12.5	636	8.2	360	57	33	19	1	275	0	66	7	0.2	0	0	0
Sufco 006 (South Fork Quitchupah Creek)	27-Aug-1996	Sufco/Petersen	130	15.9	635	8.35	378					317	23	72	8	0.1	< .1	< .1	< .1
Sufco 006 (South Fork Quitchupah Creek)	22-Oct-1996	Sufco/Petersen	9	1.02	398	8.28	450					440.14	< 5.	81	14	0.3	< .1	< .1	< .1
Sufco 006 (South Fork Quitchupah Creek)	2-Jun-1997	Sufco/Petersen		21.53	805	8.3	460					469.4	< 5.	86	19	0.9	< .1	< .1	< .1
Sufco 006 (South Fork Quitchupah Creek)	18-Aug-1997	Sufco/Petersen	287	18.9	574	8.44	350					251	< 5.	77	5	0.8	< .1	< .1	31
Sufco 006 (South Fork Quitchupah Creek)	8-Oct-1997	Sufco/Petersen	184	5.5	629	8.35	380					287	< 5.	92	9	0.6	< .1	< .1	32
Sufco 006 (South Fork Quitchupah Creek)	4-Jun-1998	Sufco/Petersen	112	13.1	901	8.42	269	66	40	72	2	456	< 5.	95	32	1.1	< .1	< .1	
Sufco 006 (South Fork Quitchupah Creek)	3-Aug-1998	Sufco/Petersen	224	22.75	577	8.08	359	55	31	17	2	135	72	70	5	1.4	< .01	< .01	
Sufco 006 (South Fork Quitchupah Creek)	1-Oct-1998	Sufco/Petersen	72	11.54	626	8.33	380	54	34	23	2	292	< 5.	70	9	0.5	< .1	< .1	
Sufco 006 (South Fork Quitchupah Creek)	21-Jun-1999	Sufco/Petersen	201	17.3	625	8.19	353	55	33	17	1	290	5	73	5	1.5	< .1	< .1	
Sufco 006 (South Fork Quitchupah Creek)	9-Aug-1999	Sufco/Petersen	394	22.04	592	8.3	338	50	31	17	1	273	6	70	5	4.1	< .1	< .1	
Sufco 006 (South Fork Quitchupah Creek)	4-Oct-1999	Sufco/Petersen	193	12.11	647	8.3	364	54	32	21	1	275	6	88	6	0.6	< .1	< .1	
Sufco 006 (South Fork Quitchupah Creek)	21-Jun-2000	Sufco/Petersen	1	15.32	627	8.13	374	53	32	18	1	258	9	94	5	3.7	< .1	< .1	
Sufco 006 (South Fork Quitchupah Creek)	2-Aug-2000	Sufco/Petersen	193	21.3	600	8.39	364	51	32	16	2	263	< 5.	89	4	2.9	< .1	< .1	
Sufco 006 (South Fork Quitchupah Creek)	5-Oct-2000	Sufco/Petersen	180	9	747	8.12	399	59	35	34	2	323	< 5.	90	13	0.5	< .1	< .1	
Sufco 006 (South Fork Quitchupah Creek)	11-Jun-2001	Sufco/Petersen	646	17.5	592	8.34	330	53	30	13	< 1.	237	8	96	3	1.2	< .1	< .1	
Sufco 006 (South Fork Quitchupah Creek)	20-Aug-2001	Sufco/Petersen	179	16.3	512	8.76	354	49	31	15	1	232	9	84	3.3	1.5	< .1	< .05	
Sufco 006 (South Fork Quitchupah Creek)	2-Oct-2001	Sufco/Petersen	0																
Sufco 006 (South Fork Quitchupah Creek)	8-May-2002	Sufco/Petersen	88	10.4	621	8.28	388	63	35	29	2	291	8	107	7	1.9	< .1	< .05	
Sufco 006 (South Fork Quitchupah Creek)	20-Sep-2002	Sufco/Petersen	12	16.8	721	8.47	402	63	33	37	3	301	7	107	11	2	< .1	< .05	
Sufco 006 (South Fork Quitchupah Creek)	8-Oct-2002	Sufco/Petersen	35	10.8	738	8.2	417	64	35	32	2	297	8	114	10	0.5	< .1	< .05	
Sufco 006 (South Fork Quitchupah Creek)	29-May-2003	Sufco/Petersen	1	20.9	962	8.42	571	66.1	43.2	80.1	3.77	371	< 5.	152	34	1.16	0.006	0.013	
Sufco 006 (South Fork Quitchupah Creek)	19-Sep-2003	Sufco/Petersen	26	13.5	631	8.53	458	63.4	35.5	28.9	2.25	285	10	108	9	0.447	0.009	0.005	
Sufco 006 (South Fork Quitchupah Creek)	30-Oct-2003	Sufco/Petersen	0.13	8.8	1228	8.58	828	94.7	56.4	110	6.47	549	< 5.	203	45	0.162	0.008	0.021	
Sufco 006 (South Fork Quitchupah Creek)	26-Jun-2004	Sufco/Petersen	420	13	493	8.77	302	50.9	30.4	10.9	1.01	184	16	95	3	1.9	< .03	0.006	
Sufco 006 (South Fork Quitchupah Creek)	1-Sep-2004	Sufco/Petersen	132	16.9	529	8.72	324	54	31.7	12.8	1.59	173	21	93	4	0.05	< .03	0.005	
Sufco 006 (South Fork Quitchupah Creek)	15-Oct-2004	Sufco/Petersen	70	9.6	593	8.47	362	56.5	31.5	20.2	1.79	218	< 5.	109	5	0.37	< .03	0.003	
Sufco 006 (South Fork Quitchupah Creek)	13-Jun-2005	Sufco/Petersen	703	15.5	523	8.37	312	63	34.8	15.4	2.17	282	< 5.	82	4	7.64	< .03	< .002	
Sufco 006 (South Fork Quitchupah Creek)	30-Sep-2005	Sufco/Petersen	402	12.1	542	8.57	338	52.2	32.6	14.5	1.35	215	16	98	3	0.77	< .03	0.007	
Sufco 006 (South Fork Quitchupah Creek)	24-Oct-2005	Sufco/Petersen	19	8.5	719	8.53	425	63.5	34	36.9	1.58	314	< 5.	93	13	< .05	< .03	0.006	
Sufco 006 (South Fork Quitchupah Creek)	26-Jun-2006	Sufco/Petersen	363	16.8	522	8.54	335	56.1	32.7	12.4	1.05	245.22	< 5.	77	4	2.93	< .03	< .002	
Sufco 006 (South Fork Quitchupah Creek)	13-Sep-2006	Sufco/Petersen	155	14.6	536	8.45	320	52.79	31.18	16.58	1.48	225	10	87	5	1.66	< .03	0.003	
Sufco 006 (South Fork Quitchupah Creek)	4-Nov-2006	Sufco/Petersen	90	3.9	591	8.48	350	59.61	34.32	28.01	1.2	281	< 5.	91	9	0.91	< .03	0.007	
Sufco 006 (South Fork Quitchupah Creek)	25-Jun-2007	Sufco/Petersen	160	17.6	543	8.62	351	55.1	33.8	14.3	0.93	244	< 5.	88	4	3.71	< .03	< .002	
Sufco 006 (South Fork Quitchupah Creek)	19-Sep-2007	Sufco/Petersen	95	12.3	515	8.89	330	50.2	33.7	17.1	1.72	128	79	95	4	0.19	< .03	0.003	
Sufco 006 (South Fork Quitchupah Creek)	29-Oct-2007	Sufco/Petersen	1	6.1	920	8.72	555	72.06	41.5	65.89	2.5	389	< 5.	122	25	0.23	< .03	0.007	
Sufco 006 (South Fork Quitchupah Creek)	12-Jun-2008	Sufco/Petersen	146	14.9	649	8.65	401	62.72	34.03	26.37	1.38	281.64	15	90	8	0.95	< .03	0.004	
Sufco 006 (South Fork Quitchupah Creek)	15-Sep-2008	Sufco/Petersen	104	11.9	518	8.63	345	56.09	33.36	14.57	1.36	224.34	< 5.	92	3	0.2	< .03	0.002	
Sufco 006 (South Fork Quitchupah Creek)	21-Oct-2008	Sufco/Petersen	1	7.2	882	8.44	578	81.24	45.53	76.47	3.87	412.09	< 5.	134	26	0.1	< .03	0.007	
Sufco 006 (South Fork Quitchupah Creek)	19-Jun-2009	Sufco/Petersen	80	16.5	617	8.46	391	65.11	35.56	25.93	1.64	273.1	26.667	95	7	2.33	< .03	0.007	
Sufco 006 (South Fork Quitchupah Creek)	17-Sep-2009	Sufco/Petersen	100	14.1	531	8.61	343	54.06	32.98	14.37	1.62	212.14	30	92	3	1.4	0.03	0.007	
Sufco 006 (South Fork Quitchupah Creek)	19-Nov-2009	Sufco/Petersen	71	0.3	612	8.39	361	56.79	34.34	21.27	1.83	256.04	< 5.	102	5	0.8	< .03	0.004	
Average			**186**	**14.0**	**707**	**8.23**	**435**	**64**	**35**	**40**	**2**	**316**	**<5**	**97**	**15**				

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^- mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^- mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 046 (Convulsion Canyon)	22-Jun-1983	Sufco/Petersen	18.0	21	880	7.9	591	76	63.36	32.5		390.4	0	159	32	0.64	0.02	0.06	0.01
Sufco 046 (Convulsion Canyon)	16-Aug-1983	Sufco/Petersen	26.9	19	980	7.8	688	72	73.44	37		429.4	0	136	50	0.33	0.01	0.015	0.01
Sufco 046 (Convulsion Canyon)	12-Oct-1983	Sufco/Petersen	35.9	11	1200	7.6	810	93.6	103.68	38	5.6	480.7	0	209	100	0.16	0.058	0.1	0.1
Sufco 046 (Convulsion Canyon)	20-Jun-1984	Sufco/Petersen	233.4	17	1150	7.55		111.2	77.76	49.9	4.2	473.4	0	158	109	0.1	0.02	0.06	0.03
Sufco 046 (Convulsion Canyon)	9-Aug-1984	Sufco/Petersen	215.4	18	1100	7.6	725	50	132	47.8		560.7	0	99	108	0.85	0.02	0.13	
Sufco 046 (Convulsion Canyon)	11-Oct-1984	Sufco/Petersen	148.1	9	1200	7.65	860	100	111.6	52		475.8	0	220	110	0.45	0.2	0.13	0.04
Sufco 046 (Convulsion Canyon)	12-Jun-1985	Sufco/Petersen	125.7	18	480	7.75	306	72.4	27.1	27	3.6	290	0	65	10.6	0.04	0.02	0.02	0.01
Sufco 046 (Convulsion Canyon)	14-Aug-1985	Sufco/Petersen	98.7	13	1400	8.1	916	92.8	111.4	110	3.3	510	0	259	96.7	0.01	0.01	0.12	0.13
Sufco 046 (Convulsion Canyon)	9-Oct-1985	Sufco/Petersen	175.0	6	1345	7.6	798	114.43	102.34	34		499	0	229	78	0.4	0.04	0.13	0.13
Sufco 046 (Convulsion Canyon)	4-Jun-1986	Sufco/Petersen	80.8	16	1326	8.1	886	87.2	107.5	42.11		468		290	64.2	0.46	0.01	0.14	0.1
Sufco 046 (Convulsion Canyon)	13-Aug-1986	Sufco/Petersen	49.4	14	1238	8	804	84.8	107	38.06		478.2	0	230	70.3	0.43	0.01	0.11	0.01
Sufco 046 (Convulsion Canyon)	8-Oct-1986	Sufco/Petersen	53.9	10	1276	8	824	92	96	37.5		405	0	264	69.6	0.43	0.01	0.12	0.08
Sufco 046 (Convulsion Canyon)	16-Jun-1987	Sufco/Petersen	35.9	19	1140	8	722	116	65.2	31.8		433	0	210	46.1	0.36	0.01	0.1	0.11
Sufco 046 (Convulsion Canyon)	5-Aug-1987	Sufco/Petersen	9.0	18	1202	8	772	85.86	80.4	34.14		421	0	187	51.6	0.3	0.01	0.12	0.11
Sufco 046 (Convulsion Canyon)	13-Oct-1987	Sufco/Petersen	184.0	13	1050	8.2	687	92.68	74.54	46.8		478	0	170	60	0.38	0.01	0.13	0.08
Sufco 046 (Convulsion Canyon)	8-Jun-1988	Sufco/Petersen	71.8	17.5	1179	7.6	680	156	51.84	34.2		483	0	191	43.1		0.25		0.08
Sufco 046 (Convulsion Canyon)	9-Aug-1988	Sufco/Petersen	44.9	19.5	1081	7.1	765	224.8	6.24	34.93		466	0	180	70.2	0.29	0.03	0.12	0.08
Sufco 046 (Convulsion Canyon)	5-Oct-1988	Sufco/Petersen	359.0	14	1168	6.8	820	212	33.6	31.83		460	0	275	43	0.11	0.03	0.09	0.06
Sufco 046 (Convulsion Canyon)	13-Jun-1989	Sufco/Petersen	26.9	29.5	873	6.2	492	88.79	42.87	21.12		341	0	166	17	0.03	0.03	0.07	0.06
Sufco 046 (Convulsion Canyon)	15-Aug-1989	Sufco/Petersen	4.0	18.3	1074	6.9	644	88.24	68.77	30.49		449	0	154	30	0.17	0.03	0.09	0.04
Sufco 046 (Convulsion Canyon)	10-Oct-1989	Sufco/Petersen	62.8	18	1079	7.6	580	89.48	67.47	30.42		459	0	150	29.6	0.08	0.03	0.02	0.01
Sufco 046 (Convulsion Canyon)	22-May-1990	Sufco/Petersen	29.6	22.5	800	7.3	518	87.6	61.42	29.39		417	0	137	24.7	0.03	0.03	0.01	0.01
Sufco 046 (Convulsion Canyon)	21-Aug-1990	Sufco/Petersen	38.6	21.1	945	8.2	536	82.13	55.9	28.43		405	0	114	23.5	0.03	0.03	0.02	
Sufco 046 (Convulsion Canyon)	16-Oct-1990	Sufco/Petersen	57.0	16.5	987	7.6	616	47.55	37.39	21.34		449	0	122	23.5	0.28	0.03	0.04	0.02
Sufco 046 (Convulsion Canyon)	28-May-1991	Sufco/Petersen	40.4	18	836	7.05	556	87.16	62.15	30.95		415	0	121	23	0.13	0.05	0.03	0.03
Sufco 046 (Convulsion Canyon)	28-Aug-1991	Sufco/Petersen	26.9	20.9	909	8.02	538	94.26	66.28	30.84		436	0	114	21.5	0.52	0	0.14	0
Sufco 046 (Convulsion Canyon)	2-Oct-1991	Sufco/Petersen	22.4	18.8	942	7.7	576	52.4	59.6	27.94		439	0	122	24	0.39	0	0.12	0
Sufco 046 (Convulsion Canyon)	11-May-1992	Sufco/Petersen	35.9	20	676	8.36	564	86.5	64.82	25.32		419	2.4	105	20.5	0.02	0.02	0	0
Sufco 046 (Convulsion Canyon)	5-Aug-1992	Sufco/Petersen	25.1	21.5	909	7.54	480	54.8	44.4	23.3	3.36	322	0	108	26	0.18	0.15	0.02	0.01
Sufco 046 (Convulsion Canyon)	7-Oct-1992	Sufco/Petersen	43.5	13.2	1075	7.82	420	76.3	57.6	25.2		368	0	130	32.8	0.31	0.05	0.08	0.02
Sufco 046 (Convulsion Canyon)	8-Jun-1993	Sufco/Petersen	44.4	17.8	1012	7.84	610	103	69.7	32.8		434	0	143	24.6	0.04	0.04	0.02	0.02
Sufco 046 (Convulsion Canyon)	12-Aug-1993	Sufco/Petersen	21.1	20.8	981	7.7	538	90.4	57.8	26.8		409	0	115	22.3	0.04	0.04	0.02	0.02
Sufco 046 (Convulsion Canyon)	5-Oct-1993	Sufco/Petersen	32.8	14	960	7.63	592	96.3	58.9	18.7		378	0	89.9	22.6	0.015	0.04	0	0
Sufco 046 (Convulsion Canyon)	8-Jun-1994	Sufco/Petersen	58.3	14.5	932	7.88	626	84.5	50.3	26.7		452	0	131	24	0.182	0.03	0.049	0.038
Sufco 046 (Convulsion Canyon)	24-Aug-1994	Sufco/Petersen	49.4	17	911	7.95	514	97	56	31		355	0	121	21	0.02	0.02	0.02	0.01
Sufco 046 (Convulsion Canyon)	3-Oct-1994	Sufco/Petersen	116.7	13.8	988	7.78	580	93	64	31		360	0	126	28	0.04	0.02	0.01	0.01
Sufco 046 (Convulsion Canyon)	7-Jun-1995	Sufco/Petersen	44.9	14.5	967	7.62	640	83	50			440	0	120	24	0	0	0	0
Sufco 046 (Convulsion Canyon)	24-Aug-1995	Sufco/Petersen	13.5	20.6	924	7.9	550	78	54	28		410	0	103	23	0	0	0	0
Sufco 046 (Convulsion Canyon)	2-Oct-1995	Sufco/Petersen	4.5	16	943	7.74	530	83	55	28	4	435	0	136	23	0	0	0	0
Sufco 046 (Convulsion Canyon)	26-Aug-1996	Sufco/Petersen	8.1	18.5	886	8.08	468					393	7	91	22	< .1	< .1	< .1	52
Sufco 046 (Convulsion Canyon)	21-Oct-1996	Sufco/Petersen	8.5	3.6	874	7.92	545					500	< 5.	126	23	< .1	< .1	< .1	55
Sufco 046 (Convulsion Canyon)	2-Jun-1997	Sufco/Petersen		15.85	978	7.87	590					440	< 5.	134	24	0.2	< .1	< .1	59
Sufco 046 (Convulsion Canyon)	11-Aug-1997	Sufco/Petersen	35.9	14.1	911	7.97	550					431	< 5.	109	23	< .1	< .1	< .1	51
Sufco 046 (Convulsion Canyon)	8-Oct-1997	Sufco/Petersen	35.9	9.59	955	8.02	590					451	< 5.	155	24	< .1	< .1	< .1	54
Sufco 046 (Convulsion Canyon)	4-Jun-1998	Sufco/Petersen	40.4	13.4	941	8.04	545	85	60	27	4	432	< 5.	129	24	< .1	< .1	< .1	
Sufco 046 (Convulsion Canyon)	3-Aug-1998	Sufco/Petersen	2.0	18.61	897	7.61	549	84	54	26	3	427	< 5.	111	25	< .1	< .1	< .1	
Sufco 046 (Convulsion Canyon)	4-Oct-1998	Sufco/Petersen	24.7	11.32	949	7.8	607	90	59	28	4	466	< 5.	105	24	< .1	< .1	< .1	
Sufco 046 (Convulsion Canyon)	17-Jun-1999	Sufco/Petersen	30.1	14.97	1004	7.61	601	87	59	33	4	451	< 5.	142	32	< .1	< .1	< .1	
Sufco 046 (Convulsion Canyon)	9-Aug-1999	Sufco/Petersen	4.5	18.64	922	7.61	552	83	51	28	4	439	< 5.	111	24	0.2	< .1	< .1	
Sufco 046 (Convulsion Canyon)	4-Oct-1999	Sufco/Petersen	31.9	9.46	978	7.91	572	90	56	27	4	471	< 5.	126	26	< .1	< .1	< .1	
Sufco 046 (Convulsion Canyon)	21-Jun-2000	Sufco/Petersen	0.0	16.26	962	7.89	571	85	55	29	4	445	< 5.	124	28	< .1	< .1	< .1	
Sufco 046 (Convulsion Canyon)	2-Aug-2000	Sufco/Petersen	20.6	17.06	909	8.01	514	82	51	26	4	415	< 5.	107	23	< .1	< .1	< .1	

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^- mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^- mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 046 (Convulsion Canyon)	5-Oct-2000	Sufco/Petersen	30.5	14	970	7.74	544	84	55	27	4	442	< 5.	124	26	< .1	< .1	< .1	
Sufco 046 (Convulsion Canyon)	11-Jun-2001	Sufco/Petersen	33.2	16.6	979	7.61	557	88	55	30	4	430	< 5.	145	28	< .1	< .1	< .1	
Sufco 046 (Convulsion Canyon)	20-Aug-2001	Sufco/Petersen	23.8	19.1	881	8.16	562	84	54	27	3	434	< 5.	117	26.3	0.1	< .1	< .05	
Sufco 046 (Convulsion Canyon)	2-Oct-2001	Sufco/Petersen	33.3	17.8	883	8.19	571	89	56	29	4	457	< 5.	123	26.7	0.2	< .1	< .05	
Sufco 046 (Convulsion Canyon)	7-May-2002	Sufco/Petersen	33.7	19.8	883	8.11	539	89	56	30	4	434	< 5.	127	26	< .1	< .1	< .05	
Sufco 046 (Convulsion Canyon)	6-Aug-2002	Sufco/Petersen	16.5	20.2	804	8.12	498	77	51	28	3	345	< 5.	109	22	< .1	< .1	< .05	
Sufco 046 (Convulsion Canyon)	25-Nov-2002	Sufco/Petersen	36.9	8.7	753	8.16	570	85	53	28	4	439	< 5.	135	25	0.2	< .1	< .05	
Sufco 046 (Convulsion Canyon)	28-May-2003	Sufco/Petersen	31.5	23.2	865	7.99	372	77.1	54.3	27.5	3.52	382	< 5.	123	23	0.222	0.008	< .005	
Sufco 046 (Convulsion Canyon)	1-Aug-2003	Sufco/Petersen	14.8	20.9	803	7.97	479	78.6	50.3	25.4	3.49	358	< 5.	107	23	0.021	< .005	< .005	
Sufco 046 (Convulsion Canyon)	5-Nov-2003	Sufco/Petersen	38.8	9.6	925	8.33	548	94.4	58.1	27.6	4.14	459	< 5.	135	25	< .02	< .005	< .005	
Sufco 046 (Convulsion Canyon)	8-Jun-2004	Sufco/Petersen	10.5	21.3	863	8.11	517	74.7	50.6	25.9	3.55	332	< 5.	119	23	0.05	< .03	0.002	
Sufco 046 (Convulsion Canyon)	24-Sep-2004	Sufco/Petersen	27.2	16.9	844	8.26	507	92.7	58.6	26	3.87	343	< 5.	116	19	< .05	< .03	< .002	
Sufco 046 (Convulsion Canyon)	17-Dec-2004	Sufco/Petersen	23.7	8.8	806	8	530	89.6	57.2	28.4	3.69	343	< 5.	136	25	< .05	< .03	< .002	
Sufco 046 (Convulsion Canyon)	24-May-2005	Sufco/Petersen	25.5	22.2	879	7.79	566	84.6	54.3	29.2	3.74	422	< 5.	136	27	< .05	< .03	< .002	
Sufco 046 (Convulsion Canyon)	28-Sep-2005	Sufco/Petersen	25.9	16.3	1005	8.23	563	94.2	54.1	41	5.06	409	5	125	50	0.34	< .03	0.017	
Sufco 046 (Convulsion Canyon)	22-Dec-2005	Sufco/Petersen	27.0	10.7	917	8.35	484	95.3	57.7	29.6	4.01	445	< 5.	129	26	0.24	< .03	0.005	
Sufco 046 (Convulsion Canyon)	22-Jun-2006	Sufco/Petersen	17.9	20.5	892	8.08	523	91.3	56.5	28.5	3.75	423	< 5.	115	23	0.97	< .03	0.008	
Sufco 046 (Convulsion Canyon)	30-Sep-2006	Sufco/Petersen	22.6	17.6	844	8.44	554	90.53	53.55	28.44	4	412	10	110	23	< .05	< .03	0.004	
Sufco 046 (Convulsion Canyon)	25-Jun-2007	Sufco/Petersen	18.1	8.8	865	8.28	565	96.86	58.9	29.29	3.73	439	< 5.	125	28	0.26	< .03	0.016	
Sufco 046 (Convulsion Canyon)	26-Sep-2007	Sufco/Petersen	22.3	19.3	826	8.05	512	84.3	52.6	17.7	3.09	367	< 5.	102	22	0.44	< .03	< .002	
Sufco 046 (Convulsion Canyon)	6-Dec-2007	Sufco/Petersen	22.4	16.2	848	8.21	533	91.6	54.3	29.3	4.03	425	< 5.	106	25	0.63	< .03	0.011	
Sufco 046 (Convulsion Canyon)	21-Dec-2007	Sufco/Petersen	31.0	7.7	879	7.7	1009	121.3	72.57	104.1	3.92	430.38		297	120	0.15	< .03	0.018	
Sufco 046 (Convulsion Canyon)	23-Jun-2008	Sufco/Petersen	24.6	20.9	875	8.09	529	89.78	56.19	28.89	3.69	414.53		114	24	< .05	< .03	0.002	
Sufco 046 (Convulsion Canyon)	25-Sep-2008	Sufco/Petersen	16.6	19.1	817	8.04	517	84.66	52.35	27.44	3.71	399.9		105	22	0.28	< .03	0.005	
Sufco 046 (Convulsion Canyon)	22-Dec-2008	Sufco/Petersen	25.8	8.4	928	8.24	587	94.83	58.66	30.51	3.92	423.07		135	26	< .05	< .03	< .002	
Sufco 046 (Convulsion Canyon)	1-Jun-2009	Sufco/Petersen	22.3	17.8	881	8.05	576	95.09	59.81	30.93	3.58	431.6		121	26	0.06	< .03	< .002	
Sufco 046 (Convulsion Canyon)	24-Sep-2009	Sufco/Petersen	17.0	17.3	845	8.23	548	89.39	57.95	28.59	4.31	440.14		108	24	0.13	< .03	0.006	
Sufco 046 (Convulsion Canyon)	3-Dec-2009	Sufco/Petersen	26.1	6.1	888	8.22	612	96.09	60.57	32.24	3.63	459.64		132	26	< .05	< .03	0.002	
Average			**47**	**16.1**	**959**	**7.86**	**596**	**92**	**62**	**33**	**4**	**426**	**<5**	**141**	**36**				
Sufco 047A (Quitchupah Creek trib b mine)	19-Apr-1983	Sufco/Petersen	53.9	12	1396	6.7	796												
Sufco 047A (Quitchupah Creek trib b mine)	5-May-1983	Sufco/Petersen	67.3	12	1230	7.4	738												
Sufco 047A (Quitchupah Creek trib b mine)	17-May-1983	Sufco/Petersen	377.0	6	1305	7.7	846												
Sufco 047A (Quitchupah Creek trib b mine)	7-Jun-1983	Sufco/Petersen	354.6	12	841	8.3	522												
Sufco 047A (Quitchupah Creek trib b mine)	20-Jun-1983	Sufco/Petersen	237.9	15	960	7.7	660	96.8	47.04	56		407.5	0	127	40	0.29	0.02	0.077	0.07
Sufco 047A (Quitchupah Creek trib b mine)	14-Jul-1983	Sufco/Petersen	448.8	16	1120	8.2	636												
Sufco 047A (Quitchupah Creek trib b mine)	16-Aug-1983	Sufco/Petersen	53.9	14	1120	7.8	804	100	60	57		409.9	0	156	90	0.09	0.08	0.033	0.025
Sufco 047A (Quitchupah Creek trib b mine)	12-Oct-1983	Sufco/Petersen	49.4	12	1030	7.6	670	103.2	58.08	55	3.1	402.6	0	193	60	0.13	0.04	0.03	0.02
Sufco 047A (Quitchupah Creek trib b mine)	20-Jun-1984	Sufco/Petersen	40.4	15	1200	7.4	770	132.8	53.52	54.1	2.2	435.5	0	190	80.4	0.1	0.07	0.1	0.04
Sufco 047A (Quitchupah Creek trib b mine)	9-Aug-1984	Sufco/Petersen	62.8	14	1090	7.4	720	130	73.2	47.8		500.2	0	89	85.4	0.3	0.07		
Sufco 047A (Quitchupah Creek trib b mine)	11-Oct-1984	Sufco/Petersen	71.8	12	1870	7.2	1200	130	79.2	285		841.8	0	190	87	0.23	0.11	0.04	0.04
Sufco 047A (Quitchupah Creek trib b mine)	12-Jun-1985	Sufco/Petersen	53.9	14	600	8.05	394	53.2	35	63	4.1	336	0	76	26.4	0.24	0.03	0.06	0.03
Sufco 047A (Quitchupah Creek trib b mine)	14-Aug-1985	Sufco/Petersen	44.9	13	1300	7.65	850	44.8	119.5	125	3.4	405	0	271	89.5	0.08	0.04	0.03	0.03
Sufco 047A (Quitchupah Creek trib b mine)	9-Oct-1985	Sufco/Petersen	67.3	10	1200	8.65	826	152.8	57.98	36	2	395	0	272	68	0.11	0.05	0.03	0.02
Sufco 047A (Quitchupah Creek trib b mine)	4-Jun-1986	Sufco/Petersen	62.8	14	1212	7.6	796	123.2	66.2	41.3		439	0	220	66.3	0.06	0.04	0.02	0.01
Sufco 047A (Quitchupah Creek trib b mine)	13-Aug-1986	Sufco/Petersen	58.3	14	1105	7.7	740	119.2	65.8	37.82		427	0	198	65.1	0.22	0.01	0.04	0.01
Sufco 047A (Quitchupah Creek trib b mine)	9-Oct-1986	Sufco/Petersen	130.2	12	1146	8	752	114.4	61.4	36		383.1	0	219	66.5	0.18	0.08	0.03	0.01
Sufco 047A (Quitchupah Creek trib b mine)	16-Jun-1987	Sufco/Petersen	49.4	16	1101	7.6	712	132	50.8	32.39		392	0	181	53	0.32	0.01	0.01	0.01
Sufco 047A (Quitchupah Creek trib b mine)	5-Aug-1987	Sufco/Petersen	49.4	16	1150	7.6	740	102.8	58.5	38.34		359	0	171	55.1	0.04	0.01	0.02	0.02
Sufco 047A (Quitchupah Creek trib b mine)	13-Oct-1987	Sufco/Petersen	71.8	14	1100	8	720	108.1	61.33	50.4		415	0	210	66	6.54	0.01	0.17	0.02
Sufco 047A (Quitchupah Creek trib b mine)	8-Jun-1988	Sufco/Petersen	53.9	14.5	1185	7.6	756	192	17.7	32.33		445	0	174	54	0.07	0.03	0.01	0.01
Sufco 047A (Quitchupah Creek trib b mine)	9-Aug-1988	Sufco/Petersen	76.3		1078	6.3	745	181.6	28.8	36.34		416	0	181	93	0.09	0.03	0.03	0.01

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^- mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^- mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 047A (Quitchupah Creek trib b mine)	5-Oct-1988	Sufco/Petersen	58.3	13.5	1154	6.1	812	184	48	32.5		440	0	270	58	0.08	0.05	0.02	0.01
Sufco 047A (Quitchupah Creek trib b mine)	13-Jun-1989	Sufco/Petersen	3.6	17	1202	6.8	692	125.7	70.8	32.32		456	0	165	49.8	0.09	0.03	0.01	0.01
Sufco 047A (Quitchupah Creek trib b mine)	15-Aug-1989	Sufco/Petersen	69.1	14.3	1164	6.3	688	82.83	64.47	33.83		438	0	160	53	0.04	0.03	0.01	0.01
Sufco 047A (Quitchupah Creek trib b mine)	10-Oct-1989	Sufco/Petersen	76.3	14.5	1142	7.2	650	110.94	61.41	31.53		458	0	141	45.9	0.05	0.04	0.01	0.01
Sufco 047A (Quitchupah Creek trib b mine)	22-May-1990	Sufco/Petersen	103.2	17.1	937	7	554	103.28	52.39	30.98		427	0	144	46	0.53	0.03	0.03	0.01
Sufco 047A (Quitchupah Creek trib b mine)	21-Aug-1990	Sufco/Petersen	71.8	16.8	1073	7.5	596	94.66	56.51	31.19		406	0	137	44.9	0.05	0.03	0.01	0.01
Sufco 047A (Quitchupah Creek trib b mine)	16-Oct-1990	Sufco/Petersen	67.8	14.3	1039	7	626	58.02	32.62	17.09		448	0	121	37.3	0.27	0.12	0.04	0.03
Sufco 047A (Quitchupah Creek trib b mine)	27-May-1991	Sufco/Petersen	134.6	15.5	1020	6.67	620	96.39	61.73	32.77		427	0	133	44	0.06	0.05	0.03	0.03
Sufco 047A (Quitchupah Creek trib b mine)	28-Aug-1991	Sufco/Petersen	58.3	17.3	1069	7.23	626	115.18	68.32	36.21		439	0	143	50	0.18	0.07	0	0
Sufco 047A (Quitchupah Creek trib b mine)	2-Oct-1991	Sufco/Petersen	71.8	16.8	1076	7.19	654	110.33	62.52	34.83		429	0	152	55.5	0.83	0.04	0.05	0
Sufco 047A (Quitchupah Creek trib b mine)	11-May-1992	Sufco/Petersen	49.4	15.5	872	7.72	692	82.02	67.54	33.44		450	0	125	53	0.11	0.02	0.03	0.03
Sufco 047A (Quitchupah Creek trib b mine)	5-Aug-1992	Sufco/Petersen	107.7	17.2	1167	6.92	680	79.2	47.9	36.1	3.17	344	0	162	71.3	0.62	0.13	0.02	0.02
Sufco 047A (Quitchupah Creek trib b mine)	7-Oct-1992	Sufco/Petersen	67.3	14	1159	7.33	740	94.3	63.8	37		364	0	158	71.6	0.23	0.22	0.02	0.22
Sufco 047A (Quitchupah Creek trib b mine)	8-Jun-1993	Sufco/Petersen	53.4	14.6	1201	7.32	716	111	64.7	41.9		445	0	167	63.3	0.04	0.04	0.02	0.02
Sufco 047A (Quitchupah Creek trib b mine)	12-Aug-1993	Sufco/Petersen	28.7	17.8	1169	7.1	646	110	60.4	37.8		400	0	145	11.2	0.04	0.04	0.023	0.02
Sufco 047A (Quitchupah Creek trib b mine)	5-Oct-1993	Sufco/Petersen	41.3	14	1048	7	644	109	60.6	37.1		348	0	164	54.7	0.208	0.05	0.02	0
Sufco 047A (Quitchupah Creek trib b mine)	8-Jun-1994	Sufco/Petersen	40.4	14.1	998	7.34	716	93.8	48.1	30.6		453	0	142	44	0.373	0.37	0.035	0.035
Sufco 047A (Quitchupah Creek trib b mine)	24-Aug-1994	Sufco/Petersen	38.6	15.8	1008	7.14	596	111	56	36		345	0	115	44	0.12	0.04	0.01	0.01
Sufco 047A (Quitchupah Creek trib b mine)	3-Oct-1994	Sufco/Petersen	44.9	13.7	1029	7.3	596	106	59	34		380	0	113	46	0.13	0.06	0.02	0.02
Sufco 047A (Quitchupah Creek trib b mine)	7-Jun-1995	Sufco/Petersen	53.9	13.8	1059	7.1	670	98	50			440	0	130	47	0	0.2	0	0
Sufco 047A (Quitchupah Creek trib b mine)	24-Aug-1995	Sufco/Petersen	53.9	17.2	1104	7.34	630	99	56	36		415	0	119	56	0.6	0	0	0
Sufco 047A (Quitchupah Creek trib b mine)	2-Oct-1995	Sufco/Petersen	44.9	16	1075	7.41	630	102	55	33	3	420	0	152	54	0	0	0	0
Sufco 047A (Quitchupah Creek trib b mine)	26-Aug-1996	Sufco/Petersen	47.6	17.2	1080	7.59	611					406	< 5.	139	49	0.1	< .1	< .1	55
Sufco 047A (Quitchupah Creek trib b mine)	21-Oct-1996	Sufco/Petersen	141.4	12.03	1079	7.46	640					427	< 5.	135	53	0.2	< .1	< .1	56
Sufco 047A (Quitchupah Creek trib b mine)	2-Jun-1997	Sufco/Petersen		15.44	1228	7.14	740					435	< 5.	172	82	0.1	< .1	< .1	61
Sufco 047A (Quitchupah Creek trib b mine)	11-Aug-1997	Sufco/Petersen	18.0	15.38	1220	7.28	740					434	< 5.	147	84	< .1	< .1	< .1	60
Sufco 047A (Quitchupah Creek trib b mine)	8-Oct-1997	Sufco/Petersen	67.3	12.07	1326	7.13	820					448	< 5.	232	14	0.2	< .1	< .1	64
Sufco 047A (Quitchupah Creek trib b mine)	4-Jun-1998	Sufco/Petersen	80.8	13.8	1341	7.26	813	121	68	61	4	442	< 5.	145	116	< .1	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	3-Aug-1998	Sufco/Petersen	2.5	16.28	1283	6.75	794	117	65	58	3	433	< 5.	179	122	0.4	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	4-Oct-1998	Sufco/Petersen	19.7	12.97	1279	6.98	806	117	63	56	4	451	< 5.	158	94	0.1	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	17-Jun-1999	Sufco/Petersen	51.2	15.19	1262	6.98	753	110	59	54	3	455	< 5.	174	97	< .1	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	9-Aug-1999	Sufco/Petersen	10.8	16.8	1283	7.05	771	107	57	58	4	432	< 5.	174	96	0.2	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	4-Oct-1999	Sufco/Petersen	58.3	12.01	1229	7.12	730	109	57	52	3	439	< 5.	179	94	< .1	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	21-Jun-2000	Sufco/Petersen		14.63	1442	7.2	911	118	66	73	4	442	< 5.	200	149	0.4	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	2-Aug-2000	Sufco/Petersen	0.04	14.02	1416	7.18	855	119	63	72	4	425	< 5.	203	134	< .1	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	5-Oct-2000	Sufco/Petersen	18.0	13	1330	6.73	789	109	62	64	3	430	< 5.	184	106	< .1	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	11-Jun-2001	Sufco/Petersen	57.4	13.8	1450	6.9	912	123	65	95	4	454	< 5.	226	159	0.2	< .1	< .1	
Sufco 047A (Quitchupah Creek trib b mine)	20-Aug-2001	Sufco/Petersen	38.7	15.3	1372	7.52	893	110	61	90	4	427	< 5.	199	134.6	< .1	< .1	< .05	
Sufco 047A (Quitchupah Creek trib b mine)	2-Oct-2001	Sufco/Petersen	38.8	15.2	1280	7.56	822	109	60	87	4	429	< 5.	215	125.9	0.2	< .1	< .05	
Sufco 047A (Quitchupah Creek trib b mine)	7-May-2002	Sufco/Petersen	62.5	14.5	1368	7.49	865	124	67	74	4	442	< 5.	242	117	< .1	< .1	< .05	
Sufco 047A (Quitchupah Creek trib b mine)	6-Aug-2002	Sufco/Petersen	41.8	15.1	1322	7.53	878	118	68	75	3	405	< 5.	262	116	< .1	< .1	< .05	
Sufco 047A (Quitchupah Creek trib b mine)	25-Nov-2002	Sufco/Petersen	49.3	11.3	1198	7.87	780	111	61	62	3	429	< 5.	203	80	< .1	< .1	< .05	
Sufco 047A (Quitchupah Creek trib b mine)	28-May-2003	Sufco/Petersen	49.3	14.1	1429	7.59	886	126	70.6	78.8	3.71	433	< 5.	256	134	0.062	0.027	0.014	
Sufco 047A (Quitchupah Creek trib b mine)	1-Aug-2003	Sufco/Petersen	47.1	14.7	1373	7.42	882	121	64.9	79.1	3.95	423	< 5.	252	125	0.066	0.015	0.016	
Sufco 047A (Quitchupah Creek trib b mine)	5-Nov-2003	Sufco/Petersen	44.9	12.6	1338	7.69	827	120	66	73.6	3.77	439	< 5.	274	98	0.074	0.027	0.01	
Sufco 047A (Quitchupah Creek trib b mine)	8-Jun-2004	Sufco/Petersen	30.4	14.5	1495	7.55	919	127	67.6	89.6	3.7	352	< 5.	246	128	< .05	< .03	< .002	
Sufco 047A (Quitchupah Creek trib b mine)	24-Sep-2004	Sufco/Petersen	38.7	14.8	1365	7.87	886	133	72.2	84.2	3.67	347	< 5.	266	112	< .05	< .03	0.006	
Sufco 047A (Quitchupah Creek trib b mine)	17-Dec-2004	Sufco/Petersen	78.2	9.1	1253	7.53	894	127	68.1	84	4.01	368	< 5.	263	111	0.07	< .03	0.028	
Sufco 047A (Quitchupah Creek trib b mine)	24-May-2005	Sufco/Petersen	46.7	15.1	1432	7.41	913	121	65.6	92.9	3.74	422	< 5.	237	130	0.14	< .03	0.015	
Sufco 047A (Quitchupah Creek trib b mine)	28-Sep-2005	Sufco/Petersen	115.0	13.2	1336	7.85	839	110	61.6	81	4.67	401	< 5.	269	98	1.05	< .03	0.039	
Sufco 047A (Quitchupah Creek trib b mine)	22-Dec-2005	Sufco/Petersen	86.0	8.5	1486	7.86	850	117	64.1	119	4.16	422	< 5.	249	145	0.15	< .03	0.024	
Sufco 047A (Quitchupah Creek trib b mine)	22-Jun-2006	Sufco/Petersen	36.6	13.6	1484	7.61	1016	130	73.5	112	4.03	413	< 5.	260	179	0.11	< .03	0.01	

Site	Date	Data Source*	Flow gpm	Water T °C	Cond µS/cm	pH SU	TDS mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	HCO_3^- mg/L	CO_3^{2-} mg/L	SO_4^{2-} mg/L	Cl^- mg/L	Fe(T) mg/L	Fe(D) mg/L	Mn(T) mg/L	Mn(D) mg/L
Sufco 047A (Quitchupah Creek trib b mine)	30-Sep-2006	Sufco/Petersen	83.7	11.8	1423	7.85	977	120.58	68.18	99.24	4.16	431	< 5.	283	117	0.12	< .03	0.023	
Sufco 047A (Quitchupah Creek trib b mine)	6-Dec-2006	Sufco/Petersen	83.7	7.2	1333	7.94	923	118.16	68.6	103.37	4.08	415	< 5.	263	130	0.16	< .03	0.044	
Sufco 047A (Quitchupah Creek trib b mine)	25-Jun-2007	Sufco/Petersen	56.6	13.3	1395	7.72	950	122	71.9	97.4	4.14	376	< 5.	298	98	0.25	< .03	0.014	
Sufco 047A (Quitchupah Creek trib b mine)	26-Sep-2007	Sufco/Petersen	82.0	11	1318	7.91	901	120	72.3	80.7	4.14	415	< 5.	296	75	0.1	< .03	0.017	
Sufco 047A (Quitchupah Creek trib b mine)	21-Dec-2007	Sufco/Petersen	74.0	8.4	1403	7.9	613	93.24	59.37	30.65	3.99	447.45	< 5.	134	28	0.07	< .03	0.006	
Sufco 047A (Quitchupah Creek trib b mine)	23-Jun-2008	Sufco/Petersen	46.8	13.9	1480	7.51	1009	131.4	78.53	95.49	4.02	415.75	< 5.	289	133	< .05	< .03	0.01	
Sufco 047A (Quitchupah Creek trib b mine)	25-Sep-2008	Sufco/Petersen	42.8	13	1395	7.46	970	124.79	74.47	87.82	3.88	404.78	< 5.	291	112	0.07	< .03	0.005	
Sufco 047A (Quitchupah Creek trib b mine)	22-Dec-2008	Sufco/Petersen	81.0	4.8	1456	7.8	961	103.36	64.41	124.51	4.58	362.11	< 5.	283	157	0.39	< .03	0.023	
Sufco 047A (Quitchupah Creek trib b mine)	1-Jun-2009	Sufco/Petersen	68.9	12.9	1347	7.55	945	119.59	71.58	89.89	4.24	376.74	< 5.	290	122	0.23	< .03	0.012	
Sufco 047A (Quitchupah Creek trib b mine)	24-Sep-2009	Sufco/Petersen	58.4	12.8	1244	7.64	843	110.98	70.2	77.45	4.06	410.88	< 5.	254	87	< .05	< .03	0.006	
Sufco 047A (Quitchupah Creek trib b mine)	3-Dec-2009	Sufco/Petersen	97.8	7.1	1233	7.69	881	117.27	70	79.39	3.83	436.48	< 5.	263	88	0.07	< .03	0.01	
Average			**73**	**13.7**	**1222**	**7.41**	**773**	**114**	**62**	**63**	**4**	**422**	**0**	**196**	**83**				

*Data sources:

Sufco/Petersen: Monitoring data collected for Canyon Fuel Company, LLC Sufco Mine as part of baseline and operational water monitoring activities.

USGS: Monitoring data presented in Thiros and Cordy, 1991 USGS Water Resources Investigations Report 90-4084

USGS Fig 17: Indicates data extracted from Figure 17 of USGS Water Resources Investigations Report 90-4084

Note: The USGS bicarbonate and carbonate data presented here is reported in the USGS publication as unspeciated alkalinity as mg/L as CaCO3.
For each of the six USGS samples, the pH is less than 7.8 and accordingly the alkalinity is reported as bicarbonate (as HCO3)

Table 3 Water level data from monitoring wells in the West Lease Modification area.

	Date	Depth to water (feet)
US-80-2	2-Nov-1982	165.35
US-80-2	25-Aug-1995	170.93
US-80-2	1-Aug-1996	170.47
US-80-2	23-Oct-1996	171.40
US-80-2	5-Jun-1997	171.00
US-80-2	18-Aug-1997	171.00
US-80-2	10-Oct-1997	171.10
US-80-2	6-Jun-1998	172.20
US-80-2	8-Aug-1998	72.40
US-80-2	4-Oct-1998	178.20
US-80-2	21-Jun-1999	172.40
US-80-2	10-Aug-1999	172.80
US-80-2	8-Oct-1999	173.40
US-80-2	22-Jun-2000	172.50
US-80-2	1-Aug-2000	172.70
US-80-2	6-Oct-2000	172.90
US-80-2	12-Jun-2001	172.70
US-80-2	20-Aug-2001	172.80
US-80-2	2-Oct-2001	172.85
US-80-2	8-May-2002	172.80
US-80-2	20-Sep-2002	173.10
US-80-2	8-Oct-2002	172.20
US-80-2	29-May-2003	172.20
US-80-2	19-Sep-2003	172.33
US-80-2	29-Oct-2003	171.86
US-80-2	26-Jun-2004	172.38
US-80-2	1-Sep-2004	172.43
US-80-2	15-Oct-2004	172.29
US-80-2	13-Jun-2005	172.96
US-80-2	30-Sep-2005	173.76
US-80-2	24-Oct-2005	173.90
US-80-2	26-Jun-2006	173.24
US-80-2	13-Sep-2006	174.11
US-80-2	4-Nov-2006	173.40
US-80-2	25-Jun-2007	173.78
US-80-2	19-Sep-2007	173.52
US-80-2	29-Oct-2007	173.66
US-80-2	12-Jun-2008	173.43
US-80-2	15-Sep-2008	173.58
US-80-2	21-Oct-2008	173.21
US-80-2	19-Jun-2009	173.19
US-80-2	17-Sep-2009	173.21
US-80-2	19-Nov-2009	173.10
US-80-2	28-Jun-2010	173.46

	Date	Depth to water (feet)
US-81-3	6/82	1579.00
US-81-3	1-Oct-1982	1579.72
US-81-3	Oct-82	1579.80
US-81-3	Jun-83	1580.70
US-81-3	Aug-83	1581.00
US-81-3	Oct-83	1582.60
US-81-3	Jun-84	1603.90
US-81-3	Aug-84	1582.70
US-81-3	Oct-84	1583.20
US-81-3	Jun-85	1602.20
US-81-3	Aug-85	1602.90
US-81-3	Oct-85	1600.80
US-81-3	Jun-86	1614.50
US-81-3	Sep-86	1605.70
US-81-3	Jun-87	1605.80
US-81-3	Aug-87	1606.20
US-81-3	Oct-87	1607.30
US-81-3	Jun-88	1607.30
US-81-3	Aug-88	1604.80
US-81-3	Jun-89	1608.50
US-81-3	Aug-89	1609.70
US-81-3	Oct-89	1623.20
US-81-3	Jun-90	1619.80
US-81-3	Aug-90	1621.40
US-81-3	Oct-90	1622.80
US-81-3	Jun-91	1629.50
US-81-3	Aug-91	1630.40
US-81-3	Jun-92	1633.00
US-81-3	Aug-92	1632.90
US-81-3	Oct-92	1633.90
US-81-3	Jun-93	1635.30
US-81-3	Aug-93	1635.80
US-81-3	Oct-93	1634.70
US-81-3	Jun-94	1631.30
US-81-3	Aug-94	1636.90
US-81-3	Jun-95	1624.80
US-81-3	6-Jun-1995	1624.80
US-81-3	Aug-95	1640.30
US-81-3	23-Aug-1995	1640.42
US-81-3	Oct-95	1638.80
US-81-3	3-Oct-1995	1638.78
US-81-3	1-Aug-1996	1667.33
US-81-3	18-Aug-1997	1617.50
US-81-3	8-Oct-1997	1618.20
US-81-4	19-Nov-2009	946.12
US-81-4	17-Sep-2009	946.30
US-81-4	19-Jun-2009	945.96

	Date	Depth to water (feet)
US-81-4	21-Oct-2008	948.44
US-81-4	15-Sep-2008	946.17
US-81-4	12-Jun-2008	945.94
US-81-4	29-Oct-2007	945.09
US-81-4	19-Sep-2007	945.20
US-81-4	25-Jun-2007	945.29
US-81-4	4-Nov-2006	944.81
US-81-4	13-Sep-2006	945.79
US-81-4	26-Jun-2006	945.50
US-81-4	24-Oct-2005	945.05
US-81-4	30-Sep-2005	945.18
US-81-4	13-Jun-2005	945.33
US-81-4	15-Oct-2004	945.76
US-81-4	1-Sep-2004	945.75
US-81-4	26-Jun-2004	946.15
US-81-4	29-Oct-2003	946.16
US-81-4	19-Sep-2003	946.27
US-81-4	29-May-2003	945.91
US-81-4	8-Oct-2002	945.88
US-81-4	20-Sep-2002	946.00
US-81-4	8-May-2002	938.60
US-81-4	2-Oct-2001	938.20
US-81-4	20-Aug-2001	938.25
US-81-4	11-Jun-2001	942.40
US-81-4	6-Oct-2000	936.60
US-81-4	1-Aug-2000	936.50
US-81-4	22-Jun-2000	936.20
US-81-4	8-Oct-1999	985.90
US-81-4	10-Aug-1999	985.40
US-81-4	30-Jun-1999	935.10
US-81-4	4-Oct-1998	935.40
US-81-4	8-Aug-1998	934.50
US-81-4	6-Jun-1998	934.90
US-81-4	10-Oct-1997	935.80
US-81-4	18-Aug-1997	935.70
US-81-4	4-Jun-1997	935.90
US-81-4	23-Oct-1996	988.80
US-81-4	27-Aug-1996	938.49
US-81-4	24-Aug-1995	956.69
US-81-4	2-Nov-1982	796.59

Table 4 Precipitation data for the Salina 24E (Sufco Mine) weather station.

Year	Total Precipitation (inches)	Percentage of Normal
1984-85	15.01	112%
1985-86	17.11	127%
1986-87	13.64	102%
1987-88	16.56	123%
1988-89	12.2	91%
1989-90	9.15	68%
1990-91	15.66	117%
1991-92	13.17	98%
1992-93	15	112%
1993-94	11.08	82%
1994-95	17.06	127%
1995-96	11.76	88%
1996-97	22.03	164%
1997-98	17.97	134%
1998-99	15.98	119%
1999-00	9.95	74%
2000-01	12.43	93%
2001-02	9.5	71%
2002-03	11.14	83%
2003-04	10.11	75%
2004-05	17.05	127%
2005-06	11.7	87%
2006-07	10.59	79%
2007-08	8.93	66%
2008-09	11.08	82%
2009-10	8.67 (Partial year Oct-June)	---

Table 5 Isotopic compositions of groundwaters surface waters in the West Lease area.

	Data Source	Date	$\delta^{2}H$ (‰)	$\delta^{18}O$ (‰)	Tritium (TU)	$\delta^{13}C$ (‰)	^{14}C (pmC)
Springs, West Lease Area							
Sufco 001	USGS (1991)	8/22/1986 ?			28.5		
Sufco 001	*Mayo (1997)*	10/3/1995	-125	-16.2	18.8	-12.4	90.70
Sufco 001	*Mayo (1997)*	6/10/1996	-122	-16.7			
Sufco 047	*Mayo (1997)*	10/4/1995	-131	-16.6	0.2	-12.3	25.27
Sufco 047	*Mayo (1997)*	6/10/1996	-127	-17.3	0.1		
Sufco 047A	*Mayo (1997)*	10/2/1995	-128	-16.3	0.8		
Sufco 047A	*Mayo (1997)*	6/10/1996	-126.5	-17	0.8		
Sufco 057A	*Mayo (1997)*	10/3/1995	-118	-15.4	13.0	-15.8	109.53
Sufco 057A	*Mayo (1997)*	6/10/1996	-120	-16.1			
Sufco Mine underground							
Box Canyon Area							
14 Left Setup Room	Petersen Hydrologic (2005)	9/20/2000			0.07	-9.9	31.42
14 Left E2 XC101	Petersen Hydrologic (2005)	9/20/2000			0.01	-10.2	24.45
Quitchupah Area							
12L 4E E3 C74 1/2	Mayo (1997)	9/18/1997	-120.06	-16.22	-0.07	-11.2	21.07
12L 4E fault	Mayo (1997)	9/18/1997	-118.55	-16.12	-0.02	-7.1	20.38
13L 4E E2 C53	Mayo (1997)	12/7/1998			-0.02	-7.2	6.28
Big Ridge Area							
5 Left XC57 Roof Drip	Petersen Hydrologic (2010)	1/25/2010			0.1	-10.37	28.45
6 Left XC16 Roof Drip	Petersen Hydrologic (2010)	1/25/2010			0.1	-10.39	28.45

Table 6 Groundwater and surface-water quality information by geologic formation and stream drainage.

	T	Cond	pH	TDS	Milligrams per liter								Milliequivalents per liter							
	T	Cond	pH	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{2-}	SO_4^{2-}	Cl^{-}	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{2-}	SO_4^{2-}	Cl^{-}
	°C	µS/cm	SU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Meq/L	Meq/L	Meq/L	Meq/L	Meq/L	Meq/L	Meq/L	Meq/L
Geologic Formation																				
North Horn Formation	13.8	578	7.3	322	92	14	9	3	326	0	11	14	4.57	1.12	0.38	0.08	5.33	0.00	0.22	0.39
Price River Formation	9.0	1243	7.7	749	116	35	95	4	359	0	230	56	5.78	2.87	4.14	0.09	5.88	0.00	4.79	1.57
Castlegate Sandstone	12.3	407	7.2	264	48	15	21	6	208	0	12	17	2.39	1.24	0.91	0.15	3.40	0.00	0.25	0.48
Star Point Sandstone	26.3	789	7.2	479	89	40	24	3	392	0	86	18	4.44	3.29	1.04	0.08	6.42	0.00	1.79	0.50
Stream																				
South Fork Quitchupah Creek	14.0	707	8.2	435	64	35	40	2	316	0	97	15	3.19	2.86	1.74	0.05	5.18	0.00	2.02	0.42
Convulsion Canyon	16.1	959	7.9	596	92	62	33	4	426	0	141	36	4.59	5.10	1.44	0.10	6.98	0.00	2.94	1.02
Quitchupah Creek Tributary b. mine	13.7	1222	7.4	773	114	62	63	4	422	0	196	83	5.69	5.10	2.74	0.10	6.92	0.00	4.08	2.34

Table 7 Recommended hydrologic monitoring protocols.

Discharge and water level measurements

Protocol	Applies to	Parameter	Frequency
A	Springs	Discharge	Quarterly when reasonably accessible
B	Monitoring wells	Depth to water	Quarterly when reasonably accessible

Water quality

Protocol	Applies to	Parameters	Table	Frequency
1	Springs	Operational field and laboratory water quality measurements for two years, then reverting to field water quality measurements only.	9	Quarterly when reasonably accessible

Table 8 Recommended discharge, water level, and water quality plan for springs and wells.

Site	Protocols	Comments
Springs		
Broad Hollow Spring	A, 1	Lower Castlegate Sandstone spring in Broad Hollow
Mud Spring	A, 1	Price River Formation spring in Mud Spring Hollow
Wells		
US-81-3	B	Well screened in the Blackhawk Formation, upper Hiawatha coal seam on Duncan Mountain

Table 9 Recommended field and laboratory operational water quality monitoring parameters for groundwater.

FIELD MEASUREMENTS	REPORTED AS
pH	pH units
Specific Conductivity	µS/cm @ 25°C
Temperature	°C
LABORATORY MEASUREMENTS	
Total Dissolved Solids	mg/L
Total Hardness (as $CaCO_3$)	mg/L
Total Alkalinity (as $CaCO_3$)	mg/L
Bicarbonate (as $CaCO_3$)	mg/L
Carbonate(as $CaCO_3$)	mg/L
Calcium (dissolved)	mg/L
Chloride	mg/L
Iron (total)	mg/L
Iron (dissolved)	mg/L
Magnesium (dissolved)	mg/L
Manganese (total)	mg/L
Manganese (dissolved)	mg/L
Potassium (dissolved)	mg/L
Sodium (dissolved)	mg/L
Sulfate	mg/L
Cations	meq/l
Anions	meq/l
Cation/Anion Balance	%

Appendix A

Laboratory Reporting Sheets

SGS

Analysis Report

May 20, 2010

CANYON FUEL CO SUFCO MINE
397 S 800 WEST
SALINA UT 84654

Client Sample ID:	Mud Spring	Sample ID By:	SUFCO
Date Sampled:	May 10, 2010	Sample Taken At:	Mud Spring
Date Received:	May 12, 2010	Sample Taken By:	Erik Petersen
Product Description:	WATER	Time Sampled:	1950
		Time Received:	1315
		Mine:	25
		Field - pH:	7.92 pH
		Field - Conductivity:	1032 umhos/cm
		Field - Temperature:	5.3 Deg. C

Comments: Dissolved Metals Filtered at Lab

SGS Minerals Sample ID: 782-1002483-001

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
Hardness, mg equivalent CaCO3/L	559	mg/L	SM2340-B	1.000	2010-05-14	11:14:00	AL
Acidity	9	mg/L	D1067	5.000	2010-05-14	12:15:00	AL
Nitrite	0.10	mg/L	EPA 300.0	0.050	2010-05-12	14:55:00	CM
Nitrate	1.00	mg/L	EPA 300.0	0.050	2010-05-12	14:55:00	CM
Ortho-Phosphate-P	0.05	mg/L	EPA 300.0	0.050	2010-05-12	14:55:00	CM
Sulfate, SO4	323	mg/L	EPA 300.0	1.000	2010-05-12	14:55:00	CM
Anions	12.40	meq/L	SM1030	0.000	2010-05-14	11:14:00	AL
Balance	1.20	%	SM1030	-10.000	2010-05-14	11:14:00	AL
Cations	12.70	meq/L	SM1030	0.000	2010-05-14	11:14:00	AL
Nitrogen, Ammonia	0.2	mg/L	SM4500-B-D	0.100	2010-05-20	08:00:00	AL
Total Dissolved Solids	799	mg/L	SM2540-C	30.000	2010-05-13	13:00:00	CM
Total Suspended Solids	75	mg/L	SM2540-D	5.000	2010-05-13	13:00:00	CM
Chloride, Cl	43	mg/L	EPA 300.0	1.000	2010-05-12	14:55:00	CM
Alkalinity, mg CaCO3/L (pH 4.5)	224	mg/L	SM2320-B	5.000	2010-05-14	08:45:00	CM
Carbonate Alkalinity as CaCO3	<5	mg/L	SM2320-B	5.000	2010-05-14	08:45:00	CM
Bicarbonate Alkalinity as CaCO3	224	mg/L	SM2320-B	5.000	2010-05-14	08:45:00	CM
METALS BY ICP							
Aluminum, Al - Dissolved	<0.03	mg/L	EPA 200.7	0.030	2010-05-13	13:46:00	CM
Arsenic, As - Dissolved	<0.01	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Barium, Ba - Dissolved	0.043	mg/L	EPA 200.7	0.002	2010-05-13	13:46:00	CM

Allen Ludington

Allen Ludington
Water Lab Supervisor

SGS North America Inc. | Minerals Services Division
2035 North Airport Road Huntington t (435) 653-2311 f (435)-653-2436 www.sgs.com/minerals

SGS

Analysis Report

May 20, 2010

CANYON FUEL CO SUFCO MINE
397 S 800 WEST
SALINA UT 84654

Client Sample ID:	Mud Spring	Sample ID By:	SUFCO
Date Sampled:	May 10, 2010	Sample Taken At:	Mud Spring
Date Received:	May 12, 2010	Sample Taken By:	Erik Petersen
Product Description:	WATER	Time Sampled:	1950
		Time Received:	1315
		Mine:	25
		Field - pH:	7.92 pH
		Field - Conductivity:	1032 umhos/cm
		Field - Temperature:	5.3 Deg. C
Comments:	Dissolved Metals Filtered at Lab		

SGS Minerals Sample ID: 782-1002483-001

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
METALS BY ICP (continued)							
Boron, B - Dissolved	0.04	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Calcium, Ca - Dissolved	164.59	mg/L	EPA 200.7	0.030	2010-05-13	13:46:00	CM
Copper, Cu - Dissolved	<0.01	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Iron, Fe - Total	3.68	mg/L	EPA 200.7	0.050	2010-05-18	11:09:00	CM
Iron, Fe - Dissolved	<0.03	mg/L	EPA 200.7	0.030	2010-05-13	13:46:00	CM
Lead, Pb - Dissolved	<0.01	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Magnesium, Mg - Dissolved	35.97	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Manganese, Mn - Total	0.179	mg/L	EPA 200.7	0.002	2010-05-18	11:09:00	CM
Manganese, Mn - Dissolved	0.044	mg/L	EPA 200.7	0.002	2010-05-13	13:46:00	CM
Potassium, K - Dissolved	3.76	mg/L	EPA 200.7	0.140	2010-05-13	13:46:00	CM
Selenium, Se - Dissolved	0.05	mg/L	EPA 200.7	0.020	2010-05-13	13:46:00	CM
Sodium, Na - Dissolved	32.95	mg/L	EPA 200.7	0.090	2010-05-13	13:46:00	CM

Allen Ludington

Allen Ludington
Water Lab Supervisor

SGS North America Inc. | Minerals Services Division
2035 North Airport Road Huntington t (435) 653-2311 f (435)-653-2436 www.sgs.com/minerals

SGS

Analysis Report

May 20, 2010

CANYON FUEL CO SUFCO MINE
397 S 800 WEST
SALINA UT 84654

Client Sample ID:	Broad Hollow Spring	Sample ID By:	SUFCO
Date Sampled:	May 10, 2010	Sample Taken At:	Broad Hollow Spring
Date Received:	May 12, 2010	Sample Taken By:	Erik Petersen
Product Description:	WATER	Time Sampled:	2030
		Time Received:	1315
		Mine:	25
		Field - pH:	7.06 pH
		Field - Conductivity:	171 umhos/cm
		Field - Temperature:	6.9 Deg. C
Comments:	Dissolved Metals Filtered at Lab		

SGS Minerals Sample ID: 782-1002483-002

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
Hardness, mg equivalent CaCO3/L	93	mg/L	SM2340-B	1.000	2010-05-14	11:14:00	AL
Acidity	11	mg/L	D1067	5.000	2010-05-14	12:15:00	AL
Nitrite	<0.05	mg/L	EPA 300.0	0.050	2010-05-12	14:55:00	CM
Nitrate	0.09	mg/L	EPA 300.0	0.050	2010-05-12	14:55:00	CM
Ortho-Phosphate-P	<0.05	mg/L	EPA 300.0	0.050	2010-05-12	14:55:00	CM
Sulfate, SO4	2	mg/L	EPA 300.0	1.000	2010-05-12	14:55:00	CM
Anions	2.47	meq/L	SM1030	0.000	2010-05-14	11:14:00	AL
Balance	1.22	%	SM1030	-10.000	2010-05-14	11:14:00	AL
Cations	2.53	meq/L	SM1030	0.000	2010-05-14	11:14:00	AL
Nitrogen, Ammonia	1.6	mg/L	SM4500-B-D	0.100	2010-05-20	08:00:00	AL
Total Dissolved Solids	195	mg/L	SM2540-C	30.000	2010-05-13	13:00:00	CM
Total Suspended Solids	48	mg/L	SM2540-D	5.000	2010-05-13	13:00:00	CM
Chloride, Cl	12	mg/L	EPA 300.0	1.000	2010-05-12	14:55:00	CM
Alkalinity, mg CaCO3/L (pH 4.5)	104	mg/L	SM2320-B	5.000	2010-05-14	08:45:00	CM
Carbonate Alkalinity as CaCO3	<5	mg/L	SM2320-B	5.000	2010-05-14	08:45:00	CM
Bicarbonate Alkalinity as CaCO3	104	mg/L	SM2320-B	5.000	2010-05-14	08:45:00	CM
METALS BY ICP							
Aluminum, Al - Dissolved	<0.03	mg/L	EPA 200.7	0.030	2010-05-13	13:46:00	CM
Arsenic, As - Dissolved	<0.01	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Barium, Ba - Dissolved	0.041	mg/L	EPA 200.7	0.002	2010-05-13	13:46:00	CM

Allen Ludington

Allen Ludington
Water Lab Supervisor

SGS

Analysis Report

May 20, 2010

CANYON FUEL CO SUFCO MINE
397 S 800 WEST
SALINA UT 84654

Client Sample ID:	Broad Hollow Spring	Sample ID By:	SUFCO
Date Sampled:	May 10, 2010	Sample Taken At:	Broad Hollow Spring
Date Received:	May 12, 2010	Sample Taken By:	Erik Petersen
Product Description:	WATER	Time Sampled:	2030
		Time Received:	1315
		Mine:	25
		Field - pH:	7.06 pH
		Field - Conductivity:	171 umhos/cm
		Field - Temperature:	6.9 Deg. C
Comments:	Dissolved Metals Filtered at Lab		

SGS Minerals Sample ID: 782-1002483-002

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
METALS BY ICP (continued)							
Boron, B - Dissolved	0.04	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Calcium, Ca - Dissolved	27.72	mg/L	EPA 200.7	0.030	2010-05-13	13:46:00	CM
Copper, Cu - Dissolved	<0.01	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Iron, Fe - Total	9.01	mg/L	EPA 200.7	0.050	2010-05-18	11:09:00	CM
Iron, Fe - Dissolved	1.63	mg/L	EPA 200.7	0.030	2010-05-13	13:46:00	CM
Lead, Pb - Dissolved	<0.01	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Magnesium, Mg - Dissolved	5.71	mg/L	EPA 200.7	0.010	2010-05-13	13:46:00	CM
Manganese, Mn - Total	1.165	mg/L	EPA 200.7	0.002	2010-05-18	11:09:00	CM
Manganese, Mn - Dissolved	1.103	mg/L	EPA 200.7	0.002	2010-05-13	13:46:00	CM
Potassium, K - Dissolved	9.47	mg/L	EPA 200.7	0.140	2010-05-13	13:46:00	CM
Selenium, Se - Dissolved	<0.02	mg/L	EPA 200.7	0.020	2010-05-13	13:46:00	CM
Sodium, Na - Dissolved	9.90	mg/L	EPA 200.7	0.090	2010-05-13	13:46:00	CM

Allen Ludington

Allen Ludington
Water Lab Supervisor

BYU *Laboratory of Isotope Geochemistry*
Department of Geological Sciences
BYU campus, Provo, Utah 84602
phone: (801) 422-3918

Client: Petersen Hydrologic, LLC
2695 N. 600 E.
Lehi, UT 84043

Reporting Date: June 29, 2010

Date Received: March 5, 2010

Project: Sufco Mine

Radiocarbon Age Analysis

Sample ID	BYU ID	Sample Date	^{14}C (pmc)	+/- 1 σ	$\delta^{13}C$ (‰)	+/- 1 σ
SUFCO 5 Left XC57 Roof Drip	8016	25-Jan-10	28.45	0.11	-10.37	0.04
SUFCO 6 Left XC16 Roof Drip	8017	25-Jan-10	22.36	0.09	-10.39	0.04

NOTES:

Pretreatment: Carbon was extracted from the water sample as barium carbonate precipitate. Carbon dioxide was recovered from the carbonate in a high-vacuum system for processing into benzene and isotopic analysis.

Comments: Percent modern carbon was calculated according to Stuvier, M. and Polach, HA, 1997, Discussion of ^{14}C data: Radiocarbon 19:355-63 by comparison against the activities of 4990C NBS oxalic acid and a total process blank. Based upon a Libby half life of 5568 years for ^{14}C.

David G. Tingey
Research Professor

BYU *Laboratory of Isotope Geochemistry*
Department of Geological Sciences
BYU campus, Provo, Utah 84602
phone: (801) 422-3918

Client: Petersen Hydrologic, LLC
2695 N. 600 E.
Lehi, UT 84043

Reporting Date: June 29, 2010

Date Received: March 5, 2010
Sample Date: January 25, 2010

Project: Sufco Mine

Sample ID **SUFCO 5 Left XC57 Roof Drip**
(BYU# 8016)

pH	7.81		
conductivity	362 uS		
Cations	mg/L	meq/L	
Calcium (Ca^{++})	49.31	2.46	EPA Method: 215.1
Magnesium (Mg^{++})	17.35	1.43	EPA Method: 242.1
Sodium (Na^{+})	6.43	0.28	EPA Method: 273.1
Potassium(K^{+})	1.47	0.04	EPA Method: 258.1
Anions			
Bicarbonate (HCO_3^-)	212.10	3.48	EPA Method: 310.1
Carbonate (CO_3^{--})	0.00	0.00	Alk. (Titrimetric, ph 8.3)
Fluoride (F^-)	0.18	0.01	EPA Method: 300.0
Chloride (Cl^-)	7.34	0.21	EPA Method: 300.0
Nitrite (NO_2^-)	0.00	0.00	EPA Method: 300.0
Nitrate (NO_3^-)	0.07	0.00	EPA Method: 300.0
Bromide (Br^-)	0.11	0.00	EPA Method: 300.0
O-Phosphate (HPO_4^{--})	0.00	0.00	EPA Method: 300.0
Sulfate (SO_4^{--})	36.99	0.77	
Cation/Anion Balance			ASTM: D 596-83
Total cations		4.21	
Total anions		4.47	
Percentage error (%)		-3.0	

*- Indicates concentration below the detection limit for the method used.

David G. Tingey
Research Professor

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Department of Geological Sciences
BYU campus, Provo, Utah 84602
phone: (801) 422-3918

Client: Petersen Hydrologic, LLC
2695 N. 600 E.
Lehi, UT 84043

Reporting Date: June 29, 2010

Date Received: March 5, 2010
Sample Date: January 25, 2010

Project: Sufco Mine

Sample ID **SUFCO 6 Left XC16 Roof Drip**
(BYU# 8017)

pH	7.84		
conductivity	342 uS		
Cations	mg/L	meq/L	
Calcium (Ca^{++})	48.23	2.41	EPA Method: 215.1
Magnesium (Mg^{++})	19.11	1.57	EPA Method: 242.1
Sodium (Na^{+})	5.09	0.22	EPA Method: 273.1
Potassium(K^{+})	1.56	0.04	EPA Method: 258.1
Anions			
Bicarbonate (HCO_3^-)	196.00	3.21	EPA Method: 310.1
Carbonate (CO_3^{--})	0.00	0.00	Alk. (Titrimetric, ph 8.3)
Fluoride (F^-)	0.22	0.01	EPA Method: 300.0
Chloride (Cl^-)	6.70	0.19	EPA Method: 300.0
Nitrite (NO_2^-)	0.00	0.00	EPA Method: 300.0
Nitrate (NO_3^-)	0.04	0.00	EPA Method: 300.0
Bromide (Br^-)	0.15	0.00	EPA Method: 300.0
O-Phosphate (HPO_4^{--})	0.00	0.00	EPA Method: 300.0
Sulfate (SO_4^{--})	30.61	0.64	
Cation/Anion Balance			ASTM: D 596-83
Total cations		4.24	
Total anions		4.05	
Percentage error (%)		2.3	

*- Indicates concentration below the detection limit for the method used.

David G. Tingey
Research Professor